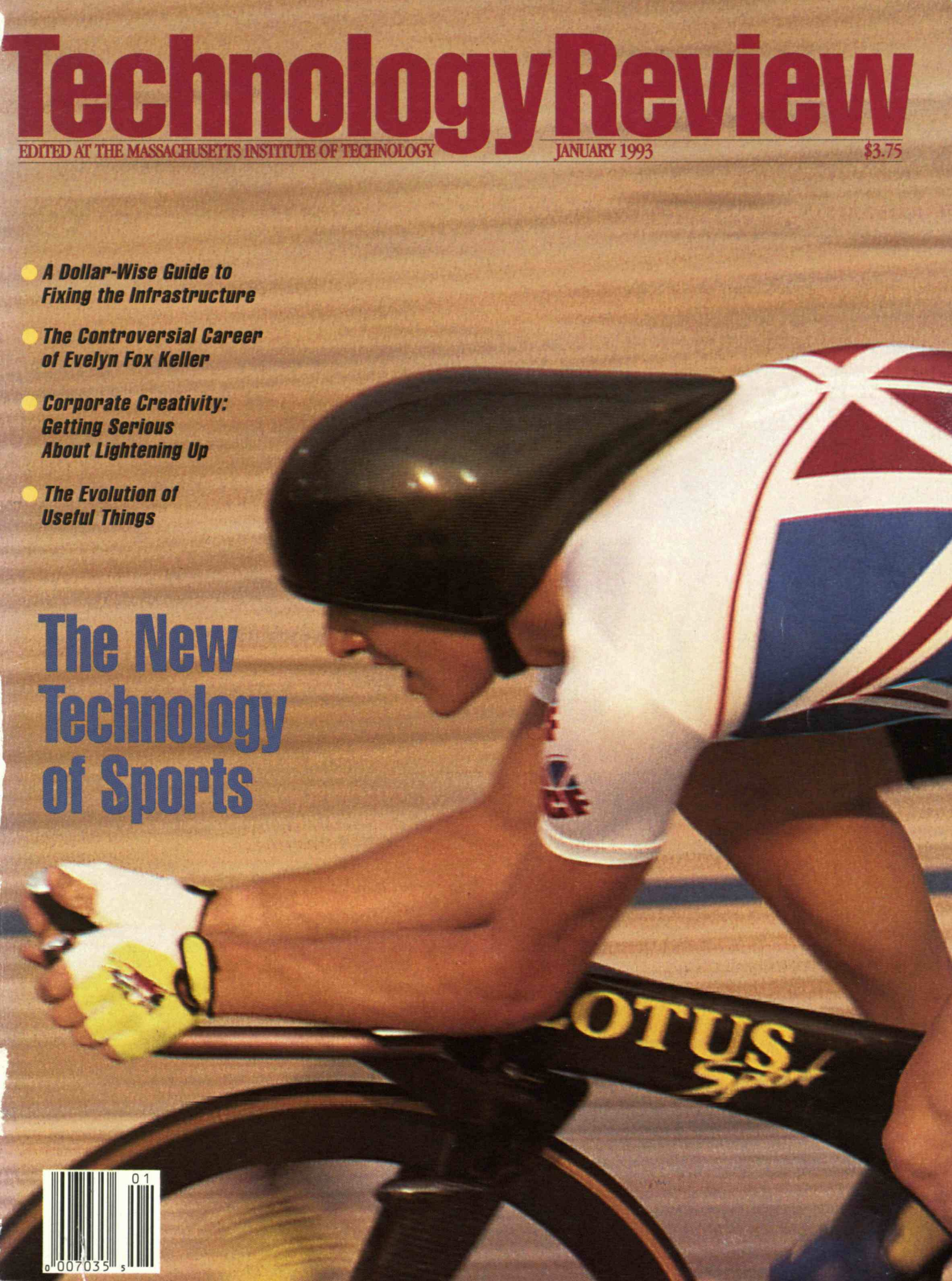
Technology Review

EDITED AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY JANUARY 1993 $3.75

- A Dollar-Wise Guide to Fixing the Infrastructure
- The Controversial Career of Evelyn Fox Keller
- Corporate Creativity: Getting Serious About Lightening Up
- The Evolution of Useful Things

The New Technology of Sports



01
0 007035 5

technology
review
Published by MIT

"Dual airbags, anti-lock traction control....it's ev

There's no question this performance sedan carries world-class credentials. And the 205-horsepower, supercharged Pontiac SSEi also delivers the control and technology of a performance-calibrated 4-speed transmission, Z-rated tires, an advanced Head-Up Display and more. All enjoyed from a driver's cockpit with rich leather seating areas. The real beauty of the exhilarating new SSEi is that you get this driving excitement for thousands less than Lexus or BMW. But then, that's exactly what you expect from the performance specialists at Pontiac.*

PONTIAC Cares

*Based on 1992 MSRP of Lexus LS400, BMW 5 and 7 series. Level of equipment varies.
PONTIAC CARES... with an extensive 3-year/36,000-mile, no-deductible warranty (see your dealer for terms of this limited warranty) plus 24-hour Roadside Assistance.
Call toll-free 1-800-762-4900 for more product information and dealer locations. Buckle Up, America!

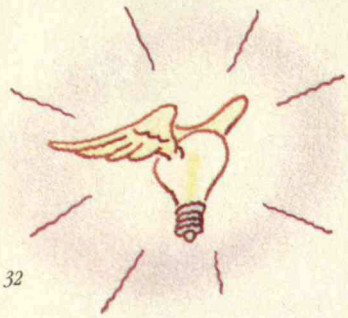

brakes,
en supercharged."
The New SSEi.
PONTIAC
WE ARE DRIVING EXCITEMENT

TECHNOLOGY REVIEW
JANUARY 1993

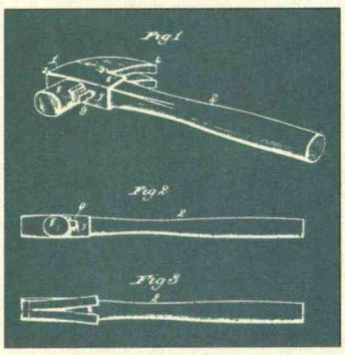
Contents

FEATURES

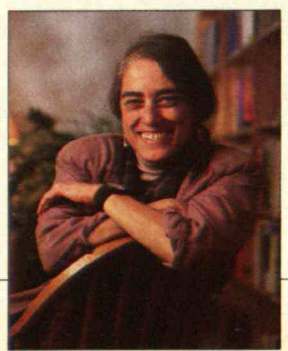
22



32



50



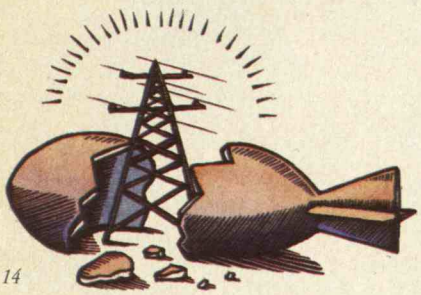
58

COVER:
PHOTOGRAPH BY JOHN BIEVER/SPORTS ILLUSTRATED

TECHNOLOGY REVIEW
VOL. 96/NO. 1

DEPARTMENTS

10



14

75

Technology Review (ISSN 0040-1692), Reg. U.S. Patent Office, is published eight times each year (January, February/March, April, May/June, July, August/September, October, and November/December) by the Association of Alumni and Alumnae of the Massachusetts Institute of Technology.

Editorial, circulation, and advertising offices: *Technology Review*, Building W59, MIT, Cambridge, MA 02139, (617) 253-8250; FAX (617) 258-7264. Printed by Lane Press, S. Burlington, VT. Second-class postage paid at Boston, MA and additional mailing offices. Postmaster: send address changes to *Technology Review*, MIT, Building W59, Cambridge, MA 02139.

Subscriptions: $30 per year. Canada add $6, other foreign countries add $12. Contact *Technology Review*, P.O. Box 489, Mount Morris, IL 61054, (800) 877-5230 or (815) 734-6309; FAX (815) 734-4205.

Advertising representatives: Mark E. Lynch, Eastern Sales Manager, 9 Salem Drive, Saratoga Springs, NY, (518) 583-6086; The Leadership Network: Kiki Paris, 200 Madison Ave. New York, NY 10016, (212) 686-1734; The Noblehart Group, Charles Hollingsworth, P.O. Box 15478, Washington, DC, (202) 547-8488; Detroit: Keith Olsen/Media, Birmingham, MI, (313) 642-2885.

A Macintosh to start a

Imagine you could design your own personal computer. What would it be? It would be fast, of course. Faster than your basic 486 machine. Fast

The Apple Macintosh Quadra.

enough to handle the rendering, animating, design and analysis jobs that often require a workstation.

It would have immense storage and memory capacity. And it would have features like high-performance networking and accelerated video support built in.

Macintosh Quadra runs all the most powerful engineering software.

You would make it flexible enough to run any kind of application. Affordable enough to put on every engineer's desk. And as long as you're fantasizing here, you'd make it as easy to set up, easy to learn and easy to use as an Apple® Macintosh® personal computer.

But it's not a fantasy. It's a Macintosh Quadra.™

By any measure, the Macintosh Quadra 700 and 950 are two of the most powerful personal computers ever built. Both are based on the Motorola 68040 (rated at 20 and 25 MIPS, running at 25 and 33 MHz), which integrates the processor, math coprocessor and RAM cache all onto one chip.

They're up to twice as fast as any of their forebears. Fast enough to beat the chips off comparably priced 486 computers from IBM, Compaq and Dell.* And fast enough to make programs like AutoCAD, MicroStation Mac,® MacBRAVO! and VersaCAD perform at a level once seen only in dauntingly complex workstations.

Built-in 24-bit video lets you create photo-realistic images without the expense of an extra card.

High-performance subsystems provide built-in support across the board: Ethernet networking, accelerated 24-bit video** support and faster SCSI and NuBus™ slots.

You can add a 400MB hard disk to both

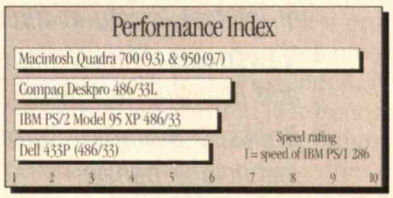
**Comparisons are based on a 1991 independent research study conducted by Ingram Laboratories that tested a variety of personal computers running applications available for both the Macintosh and Microsoft Windows 3.0 environments. **24-bit video support for up to a 16" product specifications and descriptions were supplied by the respective vendor or supplier. Orbiter images created by Jerry Flynn. ©1992 Apple Computer, Inc. Apple, the Apple logo, A/UX, Mac, Macintosh and "The power to be your best" are registered trademarks and Macintosh Quadra and is a trademark of Wolfram Research, Inc. MicroStation is a registered trademark of Bentley Systems Inc. MS-DOS is a registered trademark and Windows is a trademark of Microsoft Corp. Motorola is a registered trademark of Motorola Corp. NuBus is a trademark of Texas Instruments.*

with the power revolution.

There are two Macintosh Quadra models. The 950 sits next to your desk; the 700 fits on top of it.

communications architecture lets you easily take advantage of features like distributed processing, allowing programs like RenderPro and BackBurner to utilize excess CPU cycles on other Mac computers or workstations for faster renderings.

And Macintosh Quadra fits in with the PCs you already own. The built-in Apple SuperDrive,™ used with Apple's new Macintosh PC Exchange software, allows you to share files easily with MS-DOS PCs via floppy disk or over a network. And with Apple's fully compliant version of UNIX®—A/UX®—you can even run UNIX, X Window, MS-DOS and Macintosh programs all at the same time.



Macintosh Quadra significantly outperforms 486 PCs from IBM, Compaq and Dell running Windows 3.0.

It all adds up to the kind of power that moved *PC Week* to give the Macintosh Quadra its highest satisfaction rating in the categories of overall performance, price relative to performance, expansion capability and ease of installation and configuration.†

the 700 and the 950 to accommodate the largest CAD files. And the 950 even lets you add a CD-ROM drive or a removable cartridge drive, and a disk array or more than a gigabyte of internal hard disk storage.

You can increase the memory of the 950 to up to 64MB of RAM for handling compute-intensive applications like three-dimensional modeling and stress analysis.

Over your network, the unique Apple interapplication

Your authorized Apple reseller would be glad to show you all this and more. For the name and location of the one nearest you, call 800-538-9696, extension 200.

And soon you'll discover the latest power of Macintosh personal computers. The power to start a revolution. The power to be your best.®

—also available for 21" monitors with optional third-party video card. †PC Week, December 23/30, 1991.

Don't Ruin Your Day

...by discovering the product you've nurtured for the last year has already been made or marketed by someone else. By subscribing now to the ***World Technology/Patent Licensing Gazette*** *you can keep up with the latest technical developments, new products, processes and technologies available for license or acquisition.*

WORLD TECHNOLOGY/PATENT LICENSING GAZETTE

The Authoritive Guide to Business Opportunities in Technology obtained from a network of worldwide sources . . . Clear, Concise Information on Available Products and Processes • Business Opportunities in Technology • Innovations in Research and Development • Listings of Available Technologies in Chemical, Plastics, Pharmaceuticals, Mechanical, Electronics and other categories **. . . The Front Line News Source of Important Happenings in the Field of Technology Transfer!**

Every Bi-Monthly Issue Brings You . . .

- ***Highlights****—Quick-scan summaries of new developments, promising licensing opportunities.*
- ***Abstracts****—Essential information in capsulized abstract format for easy to spot technologies of interest to you in three sections: General & Mechanical, Chemical, and Electrical.*
- ***Newsnotes****—Timely notes on the business, technical and legal aspects of buying, selling and licensing technology.*
- ***Books & Reports****—Current publications on patents, licensing and business opportunities in technology transfer*
- ***Meetings****—Calendar of seminars. meetings, conferences, exhibits and other important events*

Order Today!
Refund Guarantee!
Free Binder with Paid Subscription!

WORLD TECHNOLOGY/ PATENT LICENSING GAZETTE

SUBSCRIPTION ORDER FORM

Send Order To: **WORLD TECHNOLOGY/PATENT LICENSING GAZETTE**
Suite 3200, Willow Grove Plaza
York & Davisville Roads, Willow Grove, PA 19090

☐ **Yes!** Please enter my subscription to World Technology/Patent Licensing Gazette for one year (six issues)
$145 - North America
$158 - Rest of the World (Add $18 for airmail)

FREE CUSTOM BINDER if order is prepaid!

☐ Payment enclosed ☐ Bill Me ☐ Bill Company

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

TELEPHONE NUMBER _____

REFUND GUARANTEE: If you are not completely satisfied, simply cancel and receive refund on undelivered portion of your subscription. TR92

First Line

The Best Way to Protect the Cows

I recently completed what I've come to call my annual *NOVA* marathon. In preparation for the yearly meeting of the science program's advisory board (on which I'm privileged to serve), my VCR and I run through all the shows of the past season. This ritual has evolved not only because of a well-deserved mistrust of my memory—even with detailed notes, it's difficult to revive impressions in October of shows that were aired in January—but because by viewing them in quick succession I can better see the season's patterns.

This year I observed a welcome trend: less "gee whiz," more realism and human drama. *NOVA* filmmakers depicted scientists and engineers not as seekers of arcane knowledge or builders of miraculous machines—no demigods in white coats—but simply as people on the job. We could watch them work together pretty much as all humans do—with frequent agony and occasional ecstasy, and with behaviors ranging from the petty to the profound. Viewers could appreciate that science and technology are social endeavors, little different from any other.

Yet this viewer couldn't help but be reminded as well that we mortals, despite our shortcomings, have much to be proud of. Common to virtually all the interactions depicted in *NOVA's* past season were admirable human qualities such as competence, dedication, persistence, compassion, bravery, humor, and strength.

Developers, engineers, and tradespeople from ironworkers to bricklayers collaborated to build a New York City skyscraper, their technical skills complemented by street-wise savvy in overcoming a steady stream of obstacles both physical and procedural. In a heartrending odyssey through Saudi Arabia and Kuwait in the aftermath of Iraq's invasion/expulsion, a wildlife biologist combined his veterinary abilities with insights into bureaucracies to rescue some of the conflict's most innocent and oil-soaked victims. Submariners in the U.S. Navy showed know-how and selflessness during an 80-day mission under the sea. Amid the infernos of oil-well fires, rough and tough teams—a kind of Hell's Angels in service to society—encountered numerous setbacks but stayed cool enough to get the job done.

In these and other *NOVA*s, no single group—whether scientists or nonscientists, whether trained at the Ivy League colleges or at the school of hard knocks—had a monopoly on determination, courage, and skill. And it was clear that all kinds of knowledge and abilities, each occupying a critical niche and each worthy of respect—were needed to accomplish any particular goal.

Most human endeavors require many hands, diverse minds, and mutual respect.

Recent articles in *Technology Review* have been making similar points. In the November/December issue, Langdon Winner analyzed the "participatory design" movement in industry, wherein workers do not passively receive new technologies but actively collaborate with other experts in shaping them. Barry Bluestone and Irving Bluestone advanced that concept further in "Workers (and Managers) of the World Unite," in which they described the growing "empowerment" of all employees—notably at GM's Saturn plant—to participate in critical decision making. Such workplace democracy, which begins with process design but could ultimately range all the way to long-term corporate strategy, say the Bluestones, serves worker and company alike.

Consider the present issue as well. In "The Idea Makers," Tom Kiely describes how U.S. companies are stimulating creativity and fostering communication throughout the ranks to abet professional growth—and to better compete.

Clark Wieman's article on infrastructure notes how cities save money and improve services when, "rather than add layers of oversight, [they] push power down the bureaucratic ladder and give project managers and resident engineers the authority to do their jobs."

And Beth Horning's engaging profile of Evelyn Fox Keller reveals how the scientist/historian questions "the deeply rooted popular mythology that casts objectivity, reason, and mind as male, and subjectivity, feeling, and nature as female." Such stereotyping and rigidity hamper the realization of scientists' goals, Keller believes; they must be replaced by a healthy pluralism that accommodates "diverse conceptions of mind and nature, and correspondingly diverse strategies."

Simplistic male/female characterizations recall the more subtle Eastern notion of yin and yang—the complementary opposites such as up/down and positive/negative that are intrinsic to the universe—where no one attribute exists in isolation or is more important than its complement. Such egalitarianism certainly applies to matters technological and economic, from the humblest projects to the ship of state, and should serve to enlighten our next presidency. As Gary Chapman lamented last issue in his analysis of the major campaigns: "Workers are viewed as beneficiaries of the elites . . . rather than as real participants in the development of technology and the strengthening of the economy." But he also expressed the hope that this "rule of the meritocracy" be reexamined "to serve the full range of human aspirations."

Perhaps we can move into the next administration more productively by heeding the wisdom of the past. An old French maxim tells us, *chacun à son métier, et les vaches seront bien gardées*: if we each do our best and contribute in our own way, the cows will be well protected. ■

—STEVEN J. MARCUS

TechnologyReview

Publisher
WILLIAM J. HECHT
Editor
STEVEN J. MARCUS
Managing Editor
SANDRA HACKMAN
Senior Editors
DAVID BRITTAN, HERB BRODY, SANDRA KNIGHT, SUSAN LEWIS, PHILIP LOPICCOLO, LAURA VAN DAM
Associate Editors
SUSANNE FAIRCLOUGH, BETH HORNING, FAITH HRUBY
Assistant to the Editors
SHERRIE SAINT JOHN
Office Manager
KATE SANGER

Design Director
KATHLEEN SAYRE
Senior Designer
NANCY L. CAHNERS
Assistant Designer
LORI NOLLET
Production Manager
SCOTT GLAZIER
Design/Production Assistant
VALERIE KIVIAT

Columnists
JOHN DEUTCH, SAMUEL FLORMAN, BENNETT HARRISON, LANGDON WINNER
Contributing Writers
DEBRA CASH, ANN MARIE CUNNINGHAM, TOM KIELY, STEVE NADIS, WADE ROUSH, SETH SHULMAN, P.J. SKERRETT, STEPHEN STRAUSS

Associate Publisher
PETER D. GELLATLY
Circulation Director
BETH BAROVICK
Assistant Marketing Manager
JAMES WOLKEN
Subscription Service Manager
LINDA MANION
Accounting
LETITIA A. TRECARTIN

Letters

HUMANITY IN MEDICINE

My hat is off to *Technology Review* for including a brief glimpse into the humanity that still exists in modern medicine (*"The Importance of Being Nurses" by Suzanne Gordon, TR October 1992*). As a former firefighter and police officer, I have spent many long hours with nurses who were caring for the wounded, the sick, and the victims of violent crime. I have also sustained injuries myself, some of which resulted in lengthy hospitalizations. In all these experiences, I have found that nurses have served selflessly.

I was particularly moved by the story of little Amy in one of the sidebars to the Gordon article (*"Sharing a Father's Grief" by Denise Maguire*). It reminded me of a brief happenstance in my past. I had responded to a sudden preterm birth—the child was so small that she seemed to fit in the palm of my hand. I tried to administer mouth-to-mouth resuscitation by lightly puffing through a gauze bandage, and then after the fire-department paramedics arrived, I drove to the hospital to complete my report. There I was met by an emergency-room nurse who patiently explained to me that the tiny infant would not make it. As I changed from writing an injury report to completing a death report, I began to cry. The nurse thoroughly discussed the medical problems of such an early birth and told me how lucky the baby was to have been held by me at the end.

I returned to patrol with a new sense of my self-worth and renewed awe for all of those who choose the emotionally arduous profession of nursing. Many may be alive today because of modern procedures and complex equipment, but it is the human heart that always determines the quality of the care received.

JOHN BURTIS
Derry, N.H.

The knowledge and skill of nurses needs to be recognized by medical colleagues and the public, and Gordon is clearly one person who "gets it."

While the focus of a surgical team is to intervene in treating disease, nurses must concern themselves with illness—the unique human experience of disease. In today's hospitals this nursing practice is crucial. Technology has helped mystify patients, making the hospital environment more unfamiliar and threatening. Nurses take patients and families beyond technology into advocacy relationships that nourish their sense of self and assist healing.

ELIZABETH M. GRADY, PhD, RN
Belmont, Mass.

FORESKIN FIGHTS

"Circumcision Circumspection" by Debra Rosenberg (*TR Trends July 1992*) falls far below the usual high journalistic standards of *Technology Review*. *The New England Journal of Medicine* piece on which it is based does argue in favor of reinstating routine circumcision, but it's not even a regular article. Rather, it's a short essay in an opinion forum.

It is striking that the author of the essay—Edgar Shoen, clinical professor of pediatrics at the University of California at San Francisco Medical School—refers to those who object to circumcision as "foreskin fundamentalists," and that he compares a procedure entailing pain, bleeding, and the risk of infection with the practice of trimming the fingernails. We have learned to reject preventive tonsillectomy and other allegedly preventive forms of surgery, and we have become very cautious in recommending other preventive measures, such as vaccinations. Why, aside from the religious issue, are we arguing about circumcision again?

LEO HERZENBERG
Chicago, Ill.

NUCLEAR INACCURACIES

In "Waiting Game for Nuclear Waste" (*TR Trends August/September 1992*), Seth Shulman says scientists believe that the spent fuel rods in cooling pools of nuclear reactors are "sufficiently cooled by the water surrounding them to prevent an explosion." The implication is that the spent fuel could, or would, explode were it not for the cooling provided by the water. But this is simply incorrect. The concentration of chain-reaction-supporting uranium in the fuel of a typical commercial reactor is about 4 percent or less by weight; weapons-grade uranium is enriched to more than 20 times this amount. Also, even this highly enriched material does not spontaneously explode—it must be set off by a smaller "trigger" explosion.

Similarly, Mr. Shulman fails to mention that the storage racks holding fuel assemblies have been fitted with dividers made of materials like boron. Such materials absorb the neutrons that would otherwise cause the chain reaction known as criticality.

Unfortunately, inaccuracies as seemingly minor as these have had a major impact on efforts to dispose of spent fuel. Since the Nuclear Waste Policy Act was legislated in 1982, inaccurate (and sometimes irresponsible) media coverage has abetted the hysteria that has arisen in the vicinity of any site under consideration for a storage facility. With visions of nuclear holocaust in their minds, it's no wonder that many local residents and politicians resist with cries of "not in my backyard."

BOB ROZIER
Washington, D.C.

IN DEFENSE OF THE F-22

"The F-22: An Exercise in Overkill" by David Callahan (*TR August/September 1992*) suggests that the decision to procure the fighter plane was based primarily on an assessment of a hypothetical Soviet threat. The author concludes that since this threat no longer exists, the planes should not be built.

But while threat assessment does play a part in decisions to procure tactical fighters, the main consideration is "structural-fatigue life"—that is, the simple fact that planes wear out. The wear and tear on an aircraft, determined by such factors as the loads it has carried and the number of takeoffs and landings it has been subjected to, accumulates in operations like Desert Storm as well as in routine training flights for fighter pilots. And as a fleet of tactical fighters begins to wear out, new fighter procurement becomes mandatory.

LEO CELNIKER
Woodland Hills, Calif.

WHOSE IRRATIONALITY?

In "The Political Pleasures of Engineering" (*TR August/September 1992*), John Sununu implies that scientists and engineers are more likely to rely on rational arguments than are politicians without technical backgrounds—in particular, environmentalists.

But environmentalists are concerned about carbon dioxide because it accounts for 75 percent of humanity's contribution to the greenhouse effect—not, as Sununu suggests, because it is related to economic growth. And even if some Americans indeed have irrational negative feelings toward new technology, the problem can only be exacerbated by the political activity of engineers like him who happen to have irrational negative feelings toward the environmental movement.

GILES NOVAK
Department of Physics
Princeton University

AUTO BACCHANALIA

It would be easy enough to lampoon "The Case for Smart Highways" by Moshe Ben-Akiva, David Bernstein, Anthony Holtz, Haris Koutsopoulos, and Joseph Sussman (*TR July 1992*). The real question in my mind is how anyone who pretends to be either a scientist or a technologist can take part in this childish bacchanalia of the automobile.

There's no doubt that vital technologies are being developed in the IVHS project. If giving scientists robot cars to play with stimulates their imagination, fine. But the great deficiencies in our transportation system, manufacturing plants, and ecological balance sheets cannot be made up by incremental improvements in cars.

TERRY SCOTT
Seattle, Wash.

STORING ENERGY IN ELECTRIC CARS

I applaud "EVs: On the Road Again" by Gill Andrews Pratt (*TR August/September 1992*). I was surprised, however, to see no mention of the flywheel as a competitive energy storage system. After all, flywheels could weigh less than batteries and store more energy. And with today's computer-aided design and improved materials, flywheels could be safe and reliable as well. Why hasn't the flywheel received the attention it deserves?

ELLIOT RING
Concord, Mass.

UNCLOGGING SCIENCE'S CAREER PIPELINE

In "Grad Students: An Endangered Species?" (*TR August/September 1992*), John Deutch presents an interesting view of the imbalance between postdocs and graduate students. But unfortunately, he can't see the forest for the trees.

Do we really want to encourage more people to become graduate students? What awaits these students after the PhD? Two or three temporary postdoc positions followed by a career change? The fact is that there's a shortage of permanent positions for PhD scientists.

Initiatives that pump more human resources into an already clogged career pipeline will not be effective in the long term. It is the top of the career ladder that needs work, not the bottom. Anything else just helps prepare a generation of students for eventual frustration.

STEVEN JANOWSKY
New Brunswick, N.J.

Continued on page 79

MIT Reporter

A Flashy Global Thermometer

An antenna on the roof of the Green Building, MIT's only certifiable skyscraper, is picking up a faint emanation inaudible to typical radio listeners. The signal is piped down to a computer on the eighteenth floor, where Earle Williams—a geophysicist in the department of Earth, Atmospheric, and Planetary Sciences—studies a monitor for vital clues about whether our planet is warming.

Lightning activity throughout the world produces an electromagnetic signal that is coupled with tropical temperatures and might prove to be an indicator of global warming.

Williams has become the first person to show that this signal—a global electromagnetic effect called the Schumann Resonance (SR), first discovered some 40 years ago—is closely coupled with temperature. The SR consists of a set of standing waves, measured in volts per meter and amperes per meter, that inhabit the space between the earth's surface and the upper atmosphere and whose lengths equal the circumference of the earth. Williams has compared the most complete record of SR data he could find, collected at the University of Rhode Island during the late 1960s and early 1970s, with global tropical temperatures measured during the same period. The SR appears to be a particularly sensitive indicator of temperature changes, with small monthly fluctuations yielding large jumps in resonance. The signal strength of the SR doubles when average tropical temperatures rise by 1° C.

This correlation, which may seem curious at first glance, makes sense according to the current view of atmospheric dynamics. When a portion of the earth's surface is hot, the lower atmosphere above that region is also relatively warm. If the air is also moist, this condition provides fuel for strong convective currents, which sweep water vapor high into the atmosphere, where it condenses and often freezes. The ice particles collide as they are transported by these currents, becoming electrically charged. The atmosphere's electric field pushes positively charged particles up and negatively charged particles down, setting the stage for brilliant lightning displays.

This explains why lightning occurs most frequently in the tropics, and why, for example, the number of lightning strikes multiplied more than 100-fold when the average monthly temperature in Darwin, Australia—just south of the equator—jumped by 2° C. This also explains why the SR, which reflects the combined echo of lightning activity from all over the world, is related to change in tropical temperatures.

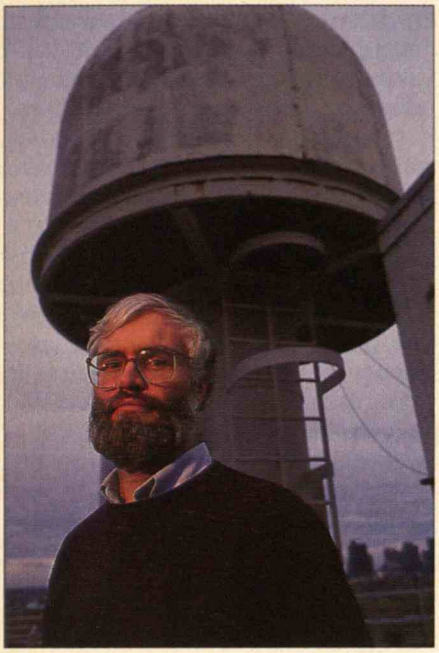
Paying attention to the SR, therefore, might alert researchers to climatic shifts in tropical regions. And because of a general circulation pattern in the atmosphere, which pumps heat from the equator to the poles, changes in tropical temperatures are strongly correlated with temperature changes elsewhere in the world, Williams says.

From a practical standpoint the SR would be useful because there are relatively few weather stations in the tropics. And the SR does not suffer from a "heat island" effect, in contrast with weather stations, which are often surrounded by parking lots, roads, and cities that boost local temperatures.

At this point, Williams' SR measurements cannot be used to gauge global temperature change. First the signal must be adjusted according to where it is picked up, he says: "Although the SR has a global value, readings vary from site to site, so you have to compensate for that." Consequently, he is comparing his findings with SR measurements from stations in Alaska and Australia. "The idea is to find everyone on earth who has the equipment to make these measurements." Then, by determining how the information differs among sites, he hopes to discern the SR's worldwide pattern and "obtain a globally representative signal from a single site."

Williams is also investigating how his SR information relates to observations of another atmospheric variable made intermittently over the past two decades by Ralph Markson, an MIT research associate. This parameter, called the ionospheric potential, represents the difference in voltage between the earth and upper atmosphere. It is maintained by

PHOTO: EDWIN KESSLER, NATIONAL SEVERE STORMS LAB



Geophysicist Earle Williams has placed an antenna and radio receiver in a protective dome on top of MIT's tallest building to continuously monitor the Schumann Resonance, an electromagnetic effect of lightning.

currents from all thunderstorms plus electrified clouds that don't produce lightning. Markson believes that frequent measurements of the ionospheric potential can provide valuable information on the role electrified clouds play in warming or cooling the planet as well as on global temperatures in general.

Markson and Williams have yet to decide whether the SR or ionospheric potential is the better indicator of worldwide temperature change. The SR can be monitored continuously with a simple antenna and radio receiver. But while measurements of the ionospheric potential must be made with weather balloons or airplanes, Markson points out that today, "in just two hours, two people can obtain a single measurement that is valid for the entire earth." Ideally, according to the researchers, both SR and ionospheric-potential information would be gathered and studied, since the figures provide complementary information.—*STEVEN J. NADIS*

COMPUTER-AIDED WALKING

Nearly a decade ago, a paraplegic woman's 10-foot walk to a podium to receive her graduation diploma made headlines and inspired a TV movie. The bigger story, however, may have been the controversy that the media coverage set off among wheelchair-bound paraplegics and researchers working on functional electrical stimulation (FES), the system that enabled the woman to take that short walk. Many experts maintained that the media oversold the technique, thus raising unrealistic hopes.

Indeed, although FES has been used in some physical-therapy programs since the early 1970s, the effort is still experimental, says William K. Durfee, an MIT mechanical engineer who, along with Allen Wiegner, an assistant professor of neurology at Harvard Medical School, is codirecting a team working to restore gait to paraplegics through a combination of FES and computer-controlled "orthotics"—braces and other orthopedic supports. Although Durfee refers to himself as "on the skeptical end" of the FES-aided field, he says his group's hybrid system should eventually enable individuals with lower-body paralysis to make short, steady walks, say, to a colleague's office at work.

Like a pacemaker, FES gait-restoration systems use electrical currents to contract and relax, and thereby move, paralyzed muscles in imitation of the currents that the body would normally generate. Typically a computer generates the current, which is transmitted to electrodes that can be implanted in a muscle or taped to or inserted through the skin. The patient activates the electrical charge by making a physical movement or by turning on a switch.

Unfortunately, most paraplegics who have used FES systems alone have experienced severe fatigue in muscles that have already atrophied. And reproducing a naturally smooth gait has been notoriously difficult because walking requires precise coordination of many muscles. Each person, in fact, employs

his or her unique combination of muscle forces and timing to walk.

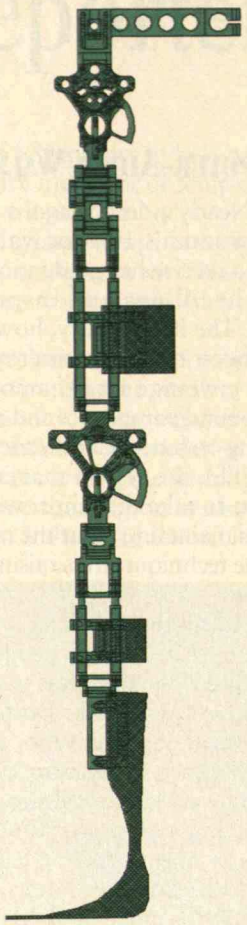
A hybrid system that combines FES with orthotics offers the most promise in alleviating problems, according to Durfee, because braces support the muscles by sharing body weight. But until now braces have typically been passive, providing proper balance only with auxiliary support such as parallel bars, walkers, and crutches.

Key to Durfee's hybrid system is a "smart" brace called a controlled-brake orthotic (CBO). It works like handbrakes that regulate the speed of a bicycle moving downhill. The CBO, which runs from the pelvis to the foot, contains braking systems at the hip and knee joints. When an electric current reaches a brake, magnetic particles between two metal plates align themselves in a way that causes one plate to rotate into the other and halt motion. Because the amount of rotation depends on the amount of current, the brakes can support positions ranging from a free to locked joint. When it locks up a joint, the brace supports the body, enabling it to reserve easily fatigued leg muscles for walking.

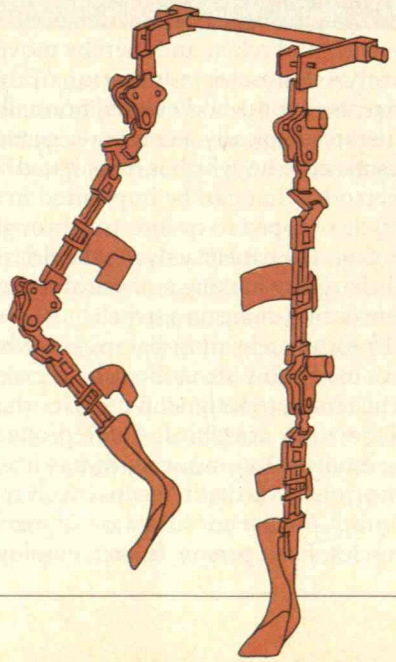
Connected to the CBO is a computer that reads information on muscle movement and velocity from sensors attached to the joints. This computer tells the FES how to stimulate the muscles and the orthotic how to brake to achieve a natural gait.

The information for the computer program comes in part from a separate computer model of the human musculoskeletal system. Having divided the lower limbs into 11 segments representing all the major joints, the model generates equations that predict the response of the whole system under various conditions, says Durfee. Besides providing general information for creating the team's hybrid system, he notes, the model should ultimately help physical therapists create customized versions.

Durfee points out that the laboratory version of the CBO, which is made of aluminum and carbon composites and is hooked to an external computer, is unwieldy and heavy. But he predicts that embedding a tiny computer into the CBO and designing and building a brace using more lightweight carbon composites, which have a higher strength-to-weight ratio than aluminum, would be fairly straightforward. Such systems would still be expensive, he says, which would make insurance companies leery of covering their purchase.



A brace that could help paraplegics take short, steady walks includes hip and knee joints, leg and feet cuffs, and a bar surrounding the hips. (The brace is diagrammed in a sketch below and an engineering drawing above.) Attached computers would electrically stimulate muscles and control braking.



Another problem, suggests Sam Maddox, publisher of *New Mobility* magazine (which focuses on paraplegics), is that researchers overestimate the demand for gait-aiding technology. While they might be interested in obtaining walking systems for cumbersome situations such as on airplanes, many wheelchair-bound people resist the idea that walking will make their lives better, he says. These people usually "come to terms with their disability."

Durfee acknowledges that many paraplegics rank walking below other potential benefits of FES research, including restoration of normal bowel and bladder function and reproductive function in men. Still, he maintains that for some people, the psychological benefits of walking are "powerful and important." What's more, he notes that even short-range walking will exercise the lower limbs, build muscle tone, and relieve pressure sores that result from sitting in a wheelchair for extended periods.

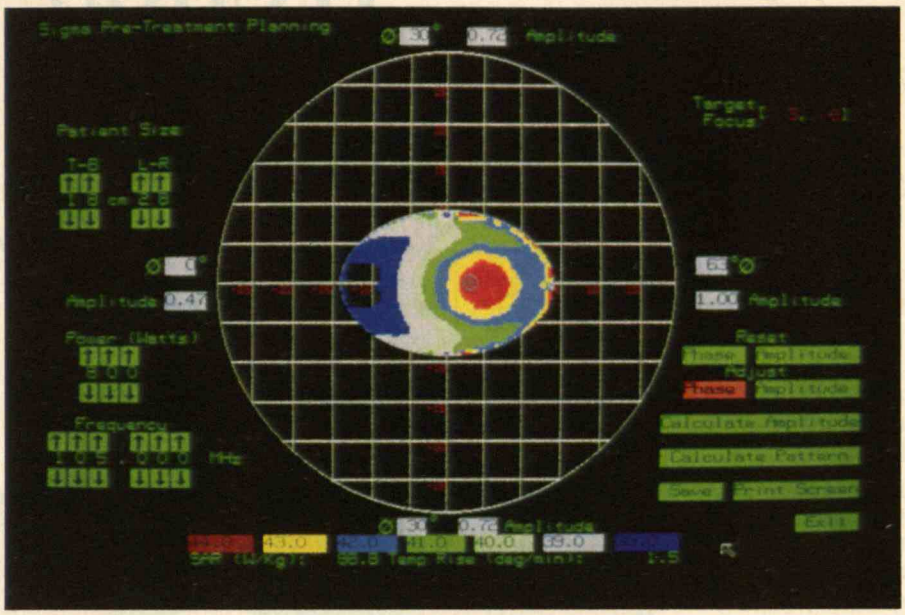
—CATHY OLOFSON *(The author is managing editor of the* American Prospect.*)*

HOMING IN ON CANCER CELLS

Physicians using heat to treat cancerous tumors have reported encouraging preliminary results. For example, a 1991 analysis in the journal *Oncology* of 15 clinical studies found that hyperthermia treatment—raising a tumor's temperature to at least 106° F for up to an hour—roughly doubled the effectiveness of x-ray therapy against melanoma and cancers of the breast and other tissues.

But doctors have had difficulty applying heat just at the site of tumors, particularly those located deep inside the

ILLUSTRATIONS: MIKE GOLDFARB



Doctors can heat body parts with radio waves to help destroy cancerous tumors. The heating pattern (red indicates the hottest region) depends on antennae adjustment, a procedure that has been recently automated by researchers at MIT's Lincoln Laboratory.

body. Delivering the heat with needles is often impractical. The procedure can be painful and dangerous because usually at least four needles are required and they sometimes must pass through several layers of tissue.

Physicians have therefore tried to apply heat without invading the body—by surrounding the patient with multiple antennas that transmit radio waves, microwaves, or ultrasound. The idea is to adjust the individual antennas so that the waves they transmit result in an overall pattern that delivers the required heat to the tumor site while minimizing the heating of healthy tissue.

That pattern is obtained by individually altering the size (or amplitude) and timing (or phase) of the waves transmitted by the different antennas. The drawback with the commercialized antenna arrays used for hyperthermia, however, is that the antennas must be adjusted manually—a relatively imprecise procedure, possibly endangering healthy tissue such as vital organs, which could be burned along with the targeted tumors.

According to Alan J. Fenn, an electrical engineer at MIT Lincoln Laboratory, an improvement may lie in adapting radar and communications technology developed by the lab for the U.S. Department of Defense. That research focused on developing software that automatically adjusts the size and timing of waves received by different antennas in a multiple-antenna system. Jamming and noise sources are blocked without seriously affecting the signals received from desired sources, such as radar waves bounced off enemy aircraft.

Fenn says that one procedure the software can use to adjust wave patterns—whether received or transmitted—is particularly well suited for hyperthermia treatment. The technique first involves "dithering" the settings—increasing and decreasing them slightly. The software monitors how these changes affect the signals received from jamming and noise sources, and with that information calculates what adjustments in antenna settings would best reduce those signals. After making those adjustments, the software repeats the dithering. The feedback process continues until the system zeroes in on the optimum settings for each of the individual antennas.

After learning about the heat-treatment problem from reading a journal article on hyperthermia, Fenn decided to see whether the Lincoln Lab software could be used if the tumor site were equated with an enemy aircraft, and healthy tissue with noise and jamming sources. He installed the software on commercial hyperthermia equipment at the State University of New York Health Science Center in Syracuse, with the help of Gerald King, director of the hospital's Hyperthermia Cancer Treatment and Research Center. The equipment, manufactured by BSD Medical Corp. of Salt Lake City, surrounds a patient with eight antennas that radiate radio-frequency waves.

So far, Fenn and King have conducted tests of the modified apparatus by placing in the system's center a slab of beef that begins to model human bone, muscle, and fat. In one test, after 80 minutes a probe at a simulated tumor spot indicated a temperature of 93° F while a probe at a reference spot read 86° (the beef was initially at a room temperature of 79°). Although the temperature at the reference spot rose 7°, the increase in a patient whose overall temperature is roughly 99° should not be nearly as high because a person's blood circulation would help to dissipate heat, Fenn says. The important result here is the 14° difference between the initial and final temperature at the target site. This suggests that the modified apparatus might be used to heat a tumor to the required level.

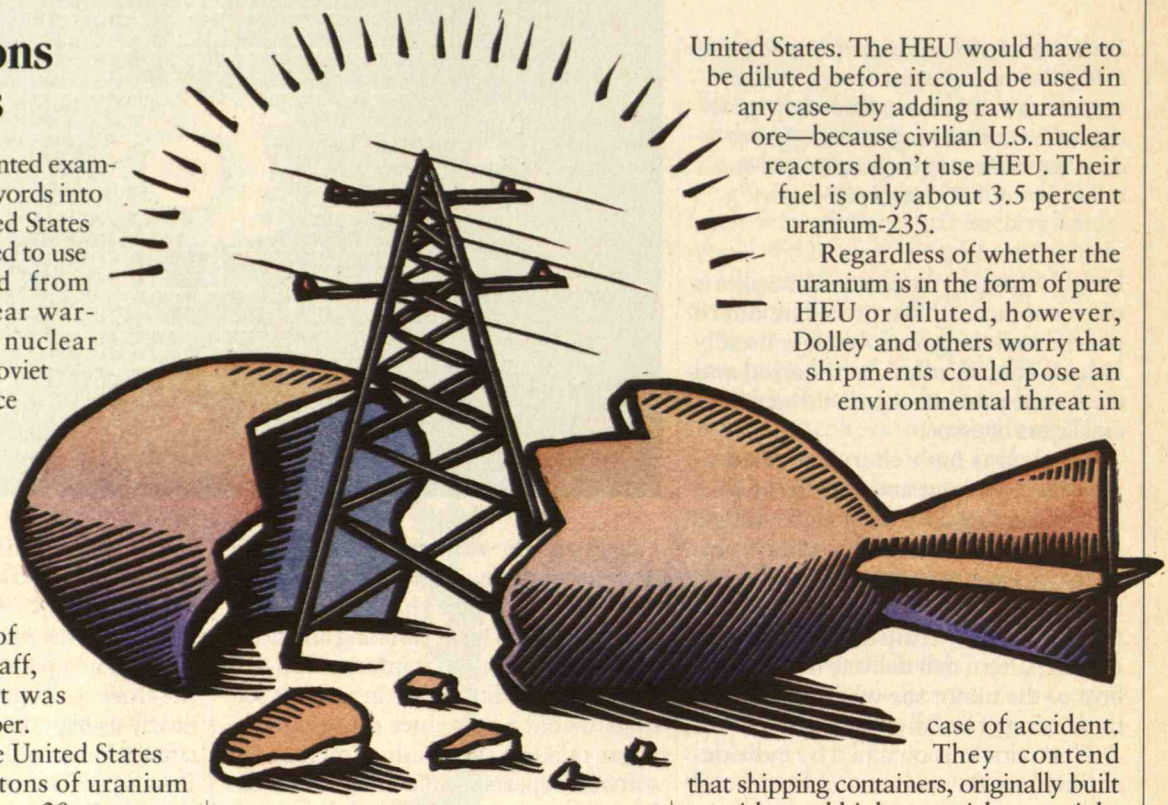
To further their research by conducting tests on lab animals, Fenn and King have applied for a grant from the National Institutes of Health. Even the preliminary results, however, have piqued the interest of BSD and two other companies that have developed commercial hyperthermia equipment. Because Fenn's software may be able to accurately control a multiple-antenna system's transmission, it might allow a device developed by one of the concerns, Labthermics Technologies of Champaign, Ill., to heat tumors deeper than 8 centimeters, the maximum depth for which the U.S. Food and Drug Administration has approved the device, and to apply more intense heat to shallow tumors, according to Everette Burdette, Labthermics' president.

—ALDEN HAYASHI *(The author is a technical editor at the* Lincoln Laboratory Journal.*)*

PHOTO: BSD MEDICAL CORP.

Trends

From Kilotons to Kilowatts



In an unprecedented example of beating swords into plowshares, the United States and Russia have agreed to use uranium reclaimed from retired Soviet nuclear warheads to fuel U.S. nuclear power plants. "The Soviet uranium that was once part of warheads aimed at us may soon be brought here to generate electricity that will light America's lamps," exulted Gen. Colin Powell, chair of the Joint Chiefs of Staff, after the agreement was announced in September.

Under the deal, the United States will buy 500 metric tons of uranium from Russia over the next 20 years at an unspecified cost that is expected to top $1 billion. The United States will buy at least 10 metric tons annually for the first 5 years and at least 30 tons each year for the next 15 years.

That's about the speed at which Russia can extract uranium from the thousands of nuclear warheads that have been or will be withdrawn from the country's nuclear stockpile under arms-control agreements, according to MIT physicist Thomas Neff, who first proposed the idea on the op-ed page of the *New York Times* in October 1991. Neff was also instrumental in bringing the two governments to the negotiating table after being invited to Russia as an adviser.

Nasty Cargo

The Russian uranium will be in a processed form, known as highly enriched uranium (HEU). While less than 1 percent of the atoms in raw uranium are of the most useful isotope for nuclear chain reactions, known as uranium-235, HEU is 97 percent uranium-235.

Because the Russian HEU would be Grade-A material for any nation intent on developing nuclear weapons, pundits have both applauded the program and raised warning flags. "It's a lot better than forcing Russia to sell the material elsewhere," says Steven Dolley, research director at the Nuclear Control Institute, a Washington D.C.-based organization that studies nuclear weapons security. But some fear that Russian shipments of HEU could become targets for hijacking. Stealing an HEU shipment would be cheaper, easier, and quicker than building the high-tech processing equipment needed for an aspiring nuclear power to produce its own HEU, Dolley says. Furthermore, a would-be nuclear state would not need to steal a huge amount. As few as 11 kilograms of pure uranium-235 metal can generate a nuclear chain reaction and thus constitute a bomb.

One solution would be to dilute the HEU in Russia before shipping it to the United States. The HEU would have to be diluted before it could be used in any case—by adding raw uranium ore—because civilian U.S. nuclear reactors don't use HEU. Their fuel is only about 3.5 percent uranium-235.

Regardless of whether the uranium is in the form of pure HEU or diluted, however, Dolley and others worry that shipments could pose an environmental threat in case of accident. They contend that shipping containers, originally built to withstand highway mishaps, might not endure a tanker collision at sea because the large amount of tanker fuel could burn hotter and longer than fuel from a truck.

To address this worry as well as to allay fears of hijacking, Neff proposes two alternatives. The first is to use military aircraft, which are already employed to transport nuclear materials. "We've been flying nuclear warheads all over the world for a long time, and I can't believe this is more dangerous," he says.

Neff's second proposal would offer yet another opportunity to turn swords into plowshares. He suggests removing the missiles from a nuclear-powered submarine and loading it with HEU. A 10-ton shipment would fit perfectly in one submarine, he says. Nuclear submarines are virtually impossible to track, so an HEU-laden sub would be invulnerable to hijacking, Neff says. Moreover, an accident at sea would not likely have severe environmental consequences, he says. "The worst that could happen would be that it would sink."

—*Vincent Kiernan*

ILLUSTRATION: RANDY LYHUS

The Volcanoes of Venus

Venus is our closest neighbor, yet its face has long remained a mystery, shrouded from the probing eyes of telescopes by a veil of dense, sulfurous clouds. Now NASA's Magellan spacecraft is using radar to raise the curtain, revealing spectacular new visions of lava flows, volcanoes, craters, and plains—a world that may be even more different from its twin, the earth, than previously expected.

Magellan, the first planetary mission launched by the space shuttle, began orbiting Venus in August 1990. Although other spacecraft, including NASA's Pioneer Venus orbiter and the former Soviet Union's Venera probes, have employed radar to make low-resolution maps of Venus, Magellan is providing more details than ever before. According to NASA project scientist R. Stephen Saunders, Magellan has sent home greater quantities of information than all past Venus missions combined. Its images are 10 times more detailed than Venera's and cover the whole planet—not just the northern portion. In fact, because Venus has no oceans obscuring the terrain, says Saunders, "we now actually have a better map of Venus than we do of the earth."

Graphic Details

Since achieving a polar orbit of Venus, Magellan has been gathering data about the planet's surface by measuring radio pulses as they make the round trip between the craft and the ground. NASA first used those measurements to create two-dimensional images at a resolution of 120 to 300 meters, depending on Magellan's distance from the planet in its elliptical orbit. A team at NASA's Jet Propulsion Laboratory (JPL) then incorporated elevation measurements to make the images look three-dimensional and added hues from Venera 13 and 14 images to produce pictures that appear nearly as realistic as photographs, according to team leader Eric DeJong.

Although the images look real, much of the information behind them is just an estimate. (Magellan took elevation readings about every 20 kilometers; everything in between was calculated.) But an experiment conducted during Magellan's second cycle led the scientists to think they could be more exact. By viewing the same regions using radar set at a slightly different angle, scientists found that they could create true 3-D, or stereo, images. So in the most recent experiment, which ran from January through September of 1992, Magellan collected a second set of images on about 25 percent of the planet.

Not only does the new stereo information yield more accurate heights of mountains and depths of craters, but it may also provide an answer to one of the hottest controversies about Venus—whether its volcanoes are still active. "Venus is just spattered with volcanoes," says Saunders. Scientists have generally thought either that the lava flows stemmed from a single period of volcanic activity about 500 million years ago or that the planet was in a constant state of volcanism.

Magellan's images suggest that neither of those two models applies. If the volcanism were a continuous process, says Raymond Arvidson, professor of earth and planetary sciences at Washington University and a member of Magellan's radar investigation group, we would see lava flows both above and below the craters. But most of the lava flows are below the craters, which means that most eruptions took place many years ago. A few on top, however, indicate more recent activity.

With the stereo data, Arvidson and others will be able to tell more about the time period and extent of volcanic activity. Unfortunately, says Arvidson, it will be several years before he and his colleagues have enough maps to answer all their questions.

Lava flows extending for hundreds of miles across the fractured plains of Venus appear in the latest Magellan photos as more weathered—and therefore more ancient—than previously thought. If volcanism has slowed, the planet's interior may be cooling.

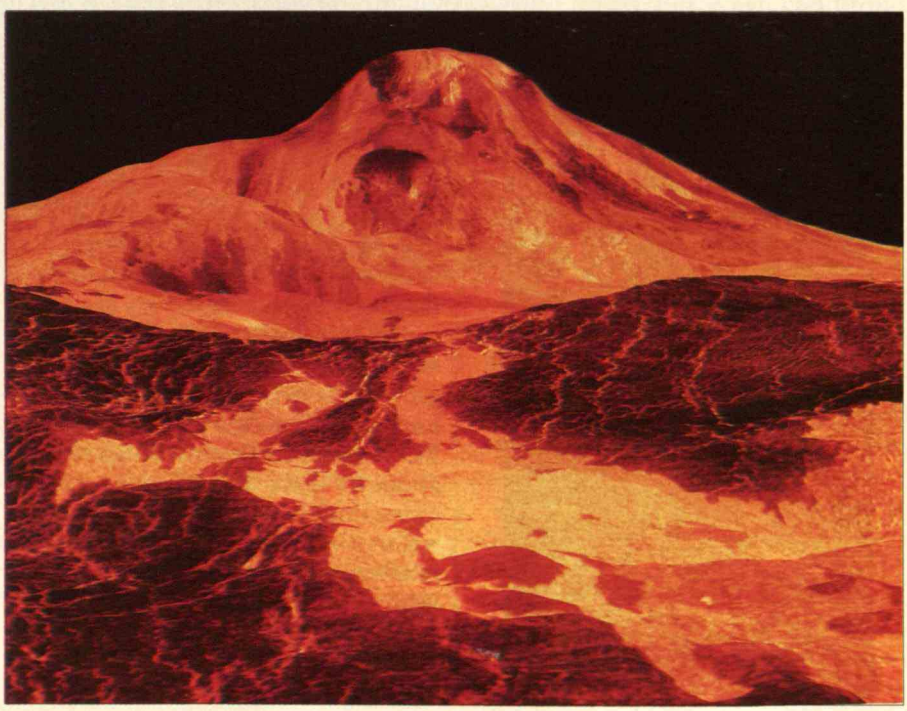


PHOTO: NASA

In the meantime, Magellan researchers are conducting another series of experiments to address the same question based on variations in gravitational pull. Using radio signals from telescopes on earth, the team determined whether Magellan sped up or slowed down as it passed over specific features of the planet, thus revealing the density of the area directly below. Areas of low density, says Arvidson, might indicate hot magma while areas of higher density would suggest solid rock.

What Makes Earth Unique

If a great deal of solid rock is detected, it would suggest that volcanism is indeed slowing and that the interior of Venus may be cooling, says Arvidson. If it is indeed occurring, the decreased volcanism and cooling could be caused by Venus's lack of oceans, he speculates. On earth, ocean water seeps through cracks in the ocean floor and becomes locked in interior rock. Once there, it lowers the melting point of the rock to help fuel volcanic activity.

If the ocean theory is accurate, it would provide further evidence that water is what makes earth unique, says JPL's Jeffrey Plaut, a scientist on the Magellan project. "It would suggest that water plays a vital role not only in biological processes but in geological processes as well." He points out that Venus probably started with all the same materials as earth, but its water evaporated because the planet is so close to the sun, he says. "Earth is in just the right place in the solar system to keep liquid water stable."

Funding for the Magellan project will run out after the gravity studies end in May. But before shutting down, the Magellan team plans to try one final test by aerobraking the spacecraft into a closer, near-circular orbit, where it could generate even higher-resolution gravity maps of Venus. NASA didn't aerobrake Magellan earlier because the spacecraft wasn't designed to enter Venus's atmosphere, where physical drag or heat from friction could damage electrical equipment, protective coatings, and solar panels. But by May, the craft will have served its useful life, and the aerobraking test will let them see whether Magellan holds up and, if so, whether more accurate gravity measurements can be obtained from a closer orbit in future missions.

Whatever Magellan's future holds, scientists will need several years to analyze the massive amounts of information the probe has sent back. "It's like trying to explore the whole earth in two years," says Saunders. The NASA team should get some help in this endeavor, since it has begun releasing mission data on CD-ROM discs for others to analyze. So far, about 65 discs from the first cycle of experiments have been released to researchers around the world. A similar number of discs from the second cycle were scheduled to be released this past November, and those from the third cycle are scheduled to be available beginning next winter. —*DEBRA ROSENBERG*

The Magellan spacecraft, shown here just after launch, is now mapping Venus's gravitational forces to help researchers determine how much of the planet's interior is solid or molten rock.

PHOTO: NASA

There's Gas in Them Thar Hills!

Though widely used for decades to fuel home heating systems, utility boilers, and industrial furnaces, natural gas has accounted for far less of the energy consumed in the United States than oil. A big reason is that fossil fuel companies have spent most of their time looking for oil; much of the natural gas they've found has been by serendipity.

But since the mid-1980s, when the sale of natural gas was deregulated, exploration has increased markedly, and estimates of how much natural gas is out there have risen with it. Numbers released in recent months are higher than ever, and they've sparked debate between companies and federal agencies over just how much natural gas exists and how much can be economically recovered.

The parties do agree on how much natural gas is already in inventory. According to the Department of Energy (DOE), the United States has 167 trillion cubic feet of proven reserves—those at existing wells that can be economically extracted with available technology. But calculations of the entire U.S. resource base—the total amount of recoverable gas estimated to exist beneath the country's turf—vary widely. The United States Geological Survey (USGS) has set the resource base at around 400 trillion cubic feet. And major oil companies peg the total at somewhere between 300 and 400 trillion cubic feet. But a 1990 study by the Potential Gas Committee, supported by the gas industry and overseen by the Colorado School of Mines, puts the resource base at 1,033 trillion cubic feet. And this past July, Enron Corp. in Houston, one of the nation's largest independent gas companies, revised its estimate up to 1,173 trillion cubic feet.

Oil folks say these estimates are biased, but they may soon have to change their tune. The National Petroleum Council, which oil companies fund, is due to release an extensive study before the end of 1992 that will put the

natural gas resource base in the neighborhood of 1,200 trillion cubic feet.

No one is more pleased with this changing view than Robert Hefner, founder and chairman of GHK Co., an independent gas producer in Oklahoma City. For 15 years Hefner has been bucking the notion that natural gas isn't plentiful enough to bother with. As far back as 1978 Hefner predicted a resource base of 1,200 to 1,500 trillion cubic feet, despite ridicule by everyone from oil executives to members of Congress.

Since the 1920s, gas estimates have been based on the amount that might be found with oil. DOE, USGS, and even the American Gas Association still base their estimates on the same expectation. But Hefner, a petroleum geologist, has long maintained that vast quantities of natural gas have formed in geologic domains where oil does not exist. In the 1980s he and comrades like Kenneth Lay, chairman of Enron, doggedly fought the oil-based projections. The trickle they started is finally reaching the mainstream; the USGS has just begun a three-year study of the natural gas that exists independently of oil, which it terms "unconventional" natural gas. Meanwhile, "gas-prone" oil companies such as Amoco, Mobil, and Chevron as well as several large gas independents such as Enron, Mesa Petroleum, and Union Pacific are now aggressively searching for natural gas.

Improved technology is partly responsible for the higher estimates. The old definition of "recoverable" was based on technology used by the oil industry since the 1950s. But gas groups are making use of rapidly evolving exploration and extraction techniques.

One example is a technique called 3-D seismic monitoring. Until recently, computers could process data from seismic surveys only into two-dimensional black-and-white maps. Geologists had to manually compare the maps against core samples taken at various depths to try to create a mental image of underground formations. New visualization software running on high-speed computer workstations can automatically incorporate the different layers of seismic data and construct three-dimensional, color-coded models of the underground formations. By manipulating the models on the computer screen, scientists can view the precise position, shape, and composition of the formations and more accurately calculate the total volume of gas that is present.

Computer visualizations help geologists identify gas reserves. In this interactive 3-D model of existing wells (black lines), black pockets sandwiched vertically between dense rock (yellow) or adjacent to fault lines (purple) are most likely to contain gas.

Recent improvements in drilling technology have also sent estimates upward. Great quantities of natural gas are readily trapped in shale, coalbed, and so-called "tight-sand" formations that run laterally inside the earth. But recovery of this gas using conventional, vertically drilled wells is ineffective; the approach does not fracture the formations enough to release significant quantities of gas. However, a recently developed technique called horizontal drilling—in which a drill bit digs into the earth, then turns at a right angle and proceeds laterally—opens these structures enough so that the gas can be recovered. "Horizontal drilling may cost twice as much, but it can yield four times as much gas," says Margaret Carson, director of competitive analysis for Enron. This stock is now being factored into the resource base.

Deep drilling is also contributing to rising estimates. Few oil wells have been drilled to depths greater than 15,000 feet because temperatures there exceed 175°C, the threshold above which oil is converted into natural gas or graphite. However, several companies, including Hefner's, have found large stores of natural gas below 20,000 feet.

Even if oil and gas proponents reach consensus on technically recoverable resources, the camps will remain divided on how much of the resource base can be *economically* recovered. According to Gen. James Randolph, DOE's assistant secretary for fossil energy, the price

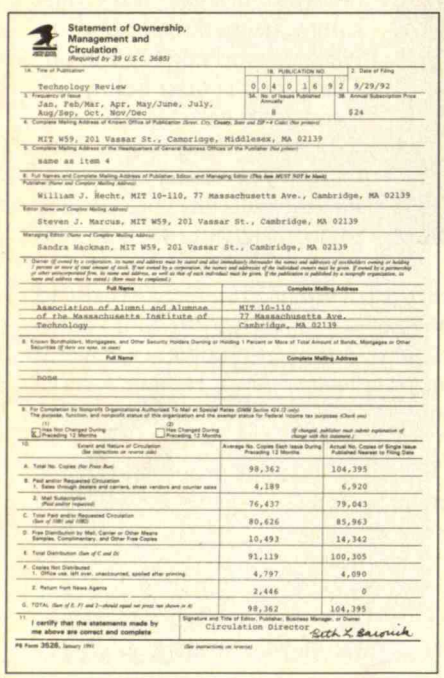
PHOTO: VITAL IMAGES, MOBIL OIL

of natural gas on the commodities market must reach a minimum of $3 per thousand cubic feet before extraction pays off. But the price of natural gas has averaged $1.62 per thousand cubic feet over the last three years, though monthly prices during the winter have reached as high as $2.39 per thousand cubic feet.

Hefner and Carson remain unfazed. New technology, they say, has improved the efficiency of exploration and recovery so dramatically that gas companies can make money even if the price of natural gas doesn't reach the "minimum."

Furthermore, they believe that new discoveries, together with the huge amounts of gas that can be recovered from each drilling operation, will lower the recovery costs. In fact, Hefner, heartened by the new projections, now predicts that the U.S. natural gas reserve is at least 5,000 trillion cubic feet, more than triple his earlier estimates. He maintains that since natural gas can exist at much higher temperatures than oil, and since oil itself often converts to natural gas below 15,000 feet, there should be as many recoverable BTUs of natural gas as there are of oil, if not many more.

—*MARK FISCHETTI*



Statement of Ownership, Management and Circulation
(Required by 39 U.S.C. 3685)

1A. Title of Publication	1B. PUBLICATION NO.	2. Date of Filing
Technology Review	0 0 4 0 1 6 9 2	9/29/92
3. Frequency of Issue: Jan, Feb/Mar, Apr, May/June, July, Aug/Sep, Oct, Nov/Dec	3A. No. of Issues Published Annually: 8	3B. Annual Subscription Price: $24

4. Complete Mailing Address of Known Office of Publication (Street, City, County, State and ZIP+4 Code) (Not printers): MIT W59, 201 Vassar St., Cambridge, Middlesex, MA 02139

5. Complete Mailing Address of the Headquarters of General Business Offices of the Publisher (Not printer): same as item 4

6. Full Names and Complete Mailing Address of Publisher, Editor, and Managing Editor (This item MUST NOT be blank)
Publisher (Name and Complete Mailing Address): William J. Hecht, MIT 10-110, 77 Massachusetts Ave., Cambridge, MA 02139
Editor (Name and Complete Mailing Address): Steven J. Marcus, MIT W59, 201 Vassar St., Cambridge, MA 02139
Managing Editor (Name and Complete Mailing Address): Sandra Hackman, MIT W59, 201 Vassar St., Cambridge, MA 02139

7. Owner (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual must be given. If the publication is published by a nonprofit organization, its name and address must be stated.) (Item must be completed.)

Full Name	Complete Mailing Address
Association of Alumni and Alumnae of the Massachusetts Institute of Technology	MIT 10-110 77 Massachusetts Ave. Cambridge, MA 02139

8. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages or Other Securities (If there are none, so state)

Full Name	Complete Mailing Address
none	

9. For Completion by Nonprofit Organizations Authorized To Mail at Special Rates (DMM Section 424.12 only)
The purpose, function, and nonprofit status of this organization and the exempt status for Federal income tax purposes (Check one)
(1) [x] Has Not Changed During Preceding 12 Months (2) [ ] Has Changed During Preceding 12 Months (If changed, publisher must submit explanation of change with this statement.)

10. Extent and Nature of Circulation (See instructions on reverse side)	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
A. Total No. Copies (Net Press Run)	98,362	104,395
B. Paid and/or Requested Circulation 1. Sales through dealers and carriers, street vendors and counter sales	4,189	6,920
2. Mail Subscription (Paid and/or requested)	76,437	79,043
C. Total Paid and/or Requested Circulation (Sum of 10B1 and 10B2)	80,626	85,963
D. Free Distribution by Mail, Carrier or Other Means Samples, Complimentary, and Other Free Copies	10,493	14,342
E. Total Distribution (Sum of C and D)	91,119	100,305
F. Copies Not Distributed 1. Office use, left over, unaccounted, spoiled after printing	4,797	4,090
2. Return from News Agents	2,446	0
G. TOTAL (Sum of E, F1 and 2—should equal net press run shown in A)	98,362	104,395

11. I certify that the statements made by me above are correct and complete. Signature and Title of Editor, Publisher, Business Manager, or Owner: Circulation Director, Beth K. Baronik

PS Form 3526, January 1991 (See instructions on reverse)

To Burn or Not to Burn

While taking a match to an oil slick may sound like the making of a chaotic inferno, emergency response specialists say burning may be the most efficient way to remove large oil spills from the ocean's surface. But tests of this technique are being resisted by environmentalists as well as the Environmental Protection Agency (EPA), which has final authority over the matter.

The debate over test burning arose most recently in Alaska when a proposal to spill and then ignite 1,000 barrels of crude on the Arctic Ocean this past summer was rejected by the EPA. In the test, Alaska Clean Seas, an oil-industry R&D cooperative, planned to tow a U-shaped boom to collect the floating oil and then ignite it with packets of burning gelled fuel hurled from a helicopter overhead.

The EPA didn't object to the technique or to the notion of burning spilled oil. However, it contends that it's not necessary to spill thousands of gallons of oil to conduct tests, and unnecessarily pollute the environment, when plenty of oil is already available from accidental spills. "I think the idea is promising," says John Cunningham, acting chief of the response standards and criteria branch of the EPA's Emergency Response Division, "but the same information could be gained from experiments on some of the 65 large oil spills reported in the United States each year."

Researchers disagree, claiming they won't be able to use the burning technique on an actual spill until it has been tested in a controlled experiment. "There is so much confusion during an emergency," says Roy Coons, instructor at the National Spill Control School at Corpus Christi State University. "The more we know ahead of time, the better we can react."

Despite EPA's reluctance to approve the oil-industry group's request for test burning, the Department of the Interior's Minerals Management Service (MMS)—with the assistance of the Department of Commerce's National Institute of Standards and Technology (NIST)—has applied for an EPA permit for a test burn in the Gulf of Mexico next summer. The test, which would involve burning a total of 50,000 gallons, would represent the final phase of a five-year study of the cleanup technique by MMS, NIST, the U.S. Coast Guard, and Environment Canada (the Canadian equivalent of the EPA).

The agencies have already conducted smaller-scale tests on land, including one on an island near Mobile, Ala., in which 4,000 gallons of oil were placed in a pan 15 meters square and burned. Within 20 minutes the fire had removed 90 percent of the oil from the surface of the pan.

The Next Logical Step

Atmospheric and water measurements from tests such as these were used to create computer models, which David Evans, head of NIST's fire-research program, hopes will be useful in convincing the EPA that further testing is both warranted and safe. For example, though environmentalists complain that large-scale test burning would unnecessarily release hazardous gases such as benzene, toluene, and xylene, NIST studies show that the amounts of these compounds released into the air from burning would be no greater, in fact, than the amounts released from evaporating crude.

Also, both water quality and aquatic life would be largely unaffected by heat from the fire. Most of the heat would rise into the air, and to compensate for the warming that does occur, boats could continuously pull the boom con-

PHOTO: SPILTECH

Though testing the technique of burning spilled oil is prohibited in the United States, Norway approved a 1988 test burn of 500 gallons of crude oil off the coast of Svalbard in the Arctic Ocean.

taining the burning oil over cooler water.

"The next logical step is to test out the computer models in large-scale experiments," says Evans. "But we may not know until next spring whether the permit is approved." The reason for the wait, Evans explains, is that besides the request from Alaska Clean Seas, theirs is the only one that EPA has received in the past decade, and since then several new environmental laws were enacted, which the EPA must take into consideration.

Some environmentalists worry that such requests for test burning are simply a smoke screen, so to speak, for not concentrating on avoiding spills in the first place. "It's disturbing to hear the oil industry tout burning," says Pamela Miller, a biologist with Greenpeace's ocean ecology campaign, "while at the same time it is trying to weaken regulations about transporting oil."

Robert Briggs, a Sierra Legal Defense Fund attorney, is concerned that the test burns are planned under unrealistically ideal conditions—when seas are calm and weather is good—just to prove that burning is a workable option.

Despite such concerns, the Canadian government is going ahead with a test burn off the coast of Newfoundland next year. Faced with a choice of test burning or the kind of shoreline contamination left in the wake of the *Exxon Valdez* disaster, Environment Canada opts for testing. Learning valuable lessons about rapid oil-spill cleanup, says Mervin Fingas, the agency's chief of emergency science, is worth the relatively minor risks to the environment that test burning would pose.

—*Lisa Busch*

Compost and Its Discontents

Because of reports that compost contains asbestos and heavy metals, communities trying to sell it as soil conditioner have found few buyers.

For American communities fearful of being buried in their own garbage, the idea of recycling waste into marketable compost sounds almost too good to be true. But some scientists worry that in the rush to compost organic materials and other garbage, regulators may have overlooked toxic substances lurking in these heaps of decaying matter. On closer inspection, researchers are finding heavy metals and asbestos in city or community compost. And while many scientists argue that the amounts of these toxins are minuscule and therefore safe, others are dismayed that the Environmental Protection Agency (EPA) has not yet determined their actual risks.

No one is terribly worried about the little heap of table scraps composting in the backyard of the average gardener. Instead, concern centers on huge municipal compost centers, which have been accepting some of the nation's estimated 160 million metric tons of municipal solid waste each year. In 1989, faced with a crisis in solid-waste disposal, the EPA recommended that communities ban yard waste from landfills and establish municipal facilities to recycle grass clippings, autumn leaves, and pruned branches into compost.

By 1991 over 1,000 communities had established compost heaps throughout the country. Many mix dry yard waste, which makes up about 18 percent of all solid waste, with sewage sludge or garbage, which is composed primarily of food and paper. These communities then market the resulting compost as a soil conditioner to spread over local landfills, golf courses, and farmland.

But in a recent analysis of samples from 26 municipal compost sites in 13 states, Donald Lisk of the Toxic Chemicals Laboratory at Cornell found asbestos and heavy metals at levels he considered disturbing. The problem is that the organic materials break down but the asbestos and metals remain, says Lisk. And over time, as more and more compost is added, these toxic substances become more concentrated.

For example, Lisk and his colleagues found asbestos fibers in 12 of 26 samples. While three samples contained only trace amounts, eight had higher than trace amounts though less than 1 percent of the total by volume, and one contained more than 1 percent asbestos. "If this compost was used as a dry potting agent in a greenhouse, the dust could be inhaled," he warns.

Lisk maintains that lead in composted municipal solid waste may also pose a health risk, particularly for children who ingest soil. Lisk found that three of nine samples contained lead in quantities greater than 300 parts per

PHOTO: JACK MACY

million, three contained more than 600 parts per million, and two others had more than 1,000 parts per million. By comparison, the proposed EPA standard for lead allowed in sewage sludge applied to soil is between 300 and 600 parts per million.

Doubts about the purity of compost could imperil the future of municipal composting. In fact, some composting communities have already been forced to pay to have their compost dumped into landfills because few buyers were willing to accept the risk.

Government researchers find such concerns groundless. Rufus Chaney, an agronomist at the Environmental Chemistry Laboratory of the USDA's Agricultural Research Service, argues that health risks can be assessed only by studying the form of the toxic substance after it has been composted, which depends on the chemistry of the composting process and the way in which these toxic substances travel through the air, soil, and food chain. As one example, he argues that the asbestos in compost does not pose a danger because it aggregates in soil particles too large to be inhaled.

Toward Federal Standards

Similarly, Chaney and James Ryan of the EPA's Risk Reduction Engineering Lab do not consider heavy metals such as cadmium a health risk in compost because the body cannot absorb the metal when it interacts with zinc, which most people consume as part of their regular diet.

The other compost metal that has caused a great deal of concern is mercury, which is readily taken up by mushrooms. But Chaney and Ryan contend that it does not pose a danger—even for those who eat unusually large quantities of mushrooms grown in compost soil—because virtually all of that mercury is in an inorganic form that is not absorbed by the body.

Chaney does agree that lead in compost presents a health risk. But he believes the problem could be overcome by convincing people to stop putting lead waste such as batteries and wine bottle caps in garbage intended for composting. Environmental organizations take his argument a step further and suggest that municipal solid waste should be pre-sorted, as it is in Europe, so that only organic matter goes into compost.

Chaney and Ryan have identified two significant agricultural problems that result when municipal compost is repeatedly applied to cropland. Boron—apparently from the glue used to make paper grocery bags—can reduce the yield of certain crops such as beans. Municipal compost also tends to be alkaline and therefore raises the soil pH, causing manganese deficiency in crops such as soybeans and wheat.

Some members of Congress are proposing that federal standards for mixed and solid-waste compost should be incorporated into the reauthorization of the Resource Conservation and Recovery Act, the legislation that regulates solid and hazardous waste. While a proposal requiring the EPA to develop standards for municipal compost was submitted to Congress last summer, the decision on whether to push for such legislation now awaits the new Congress.

As more landfills shut down in the next 10 years, says Bruce Fulford of Biothermal Associates, a consulting firm that designs compost facilities, "the major metropolitan centers are going to be flooded with compost." But although "many proponents of mixed solid-waste composting have just assumed that there were going to be markets for it," he adds, consumers must be convinced that municipal compost is safe, and that may require federal standards. In the meantime, about 20 states have drafted their own composting regulations.

—*Susan Katz Miller*

HIGH-TECH OLYM

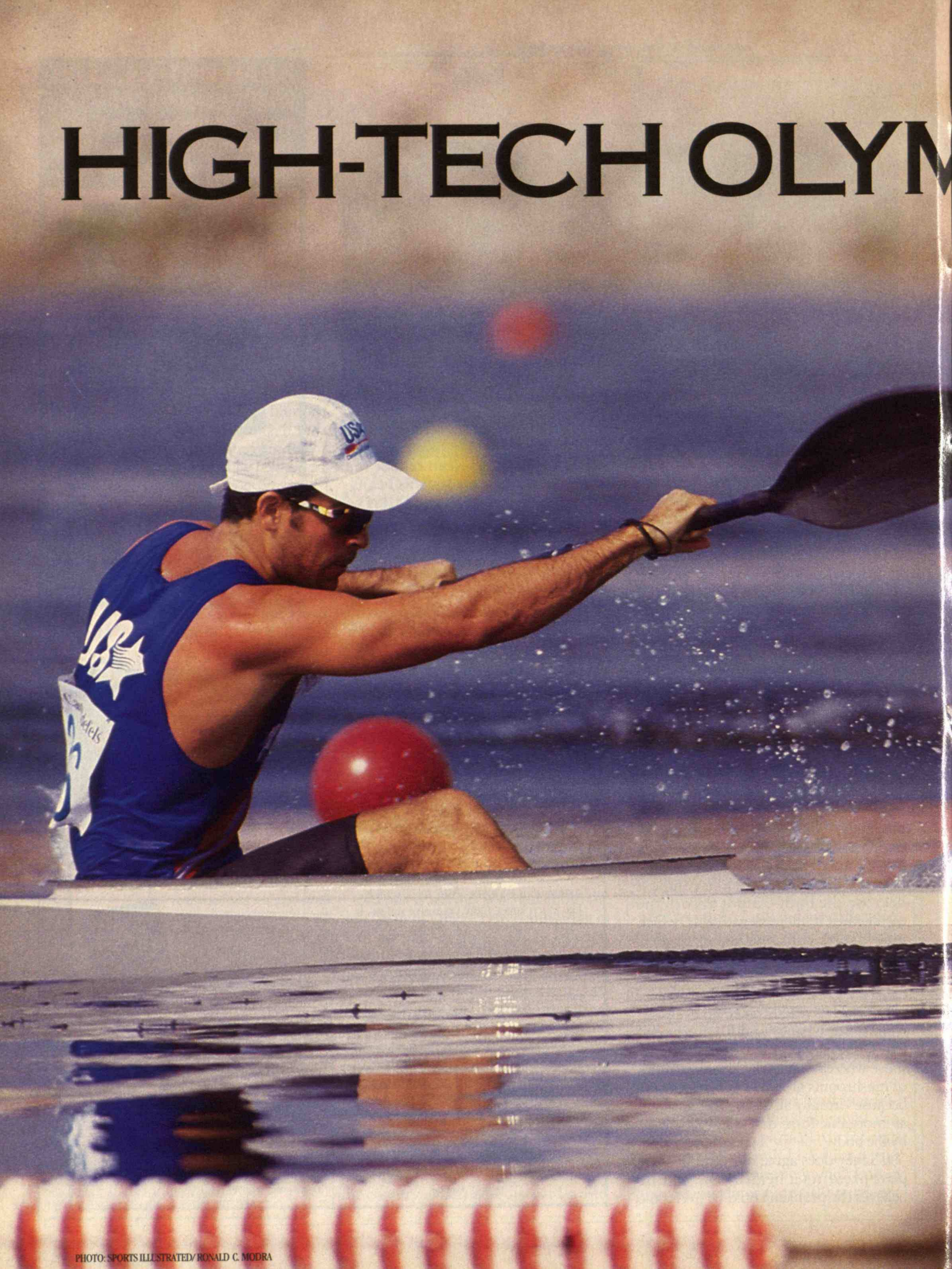
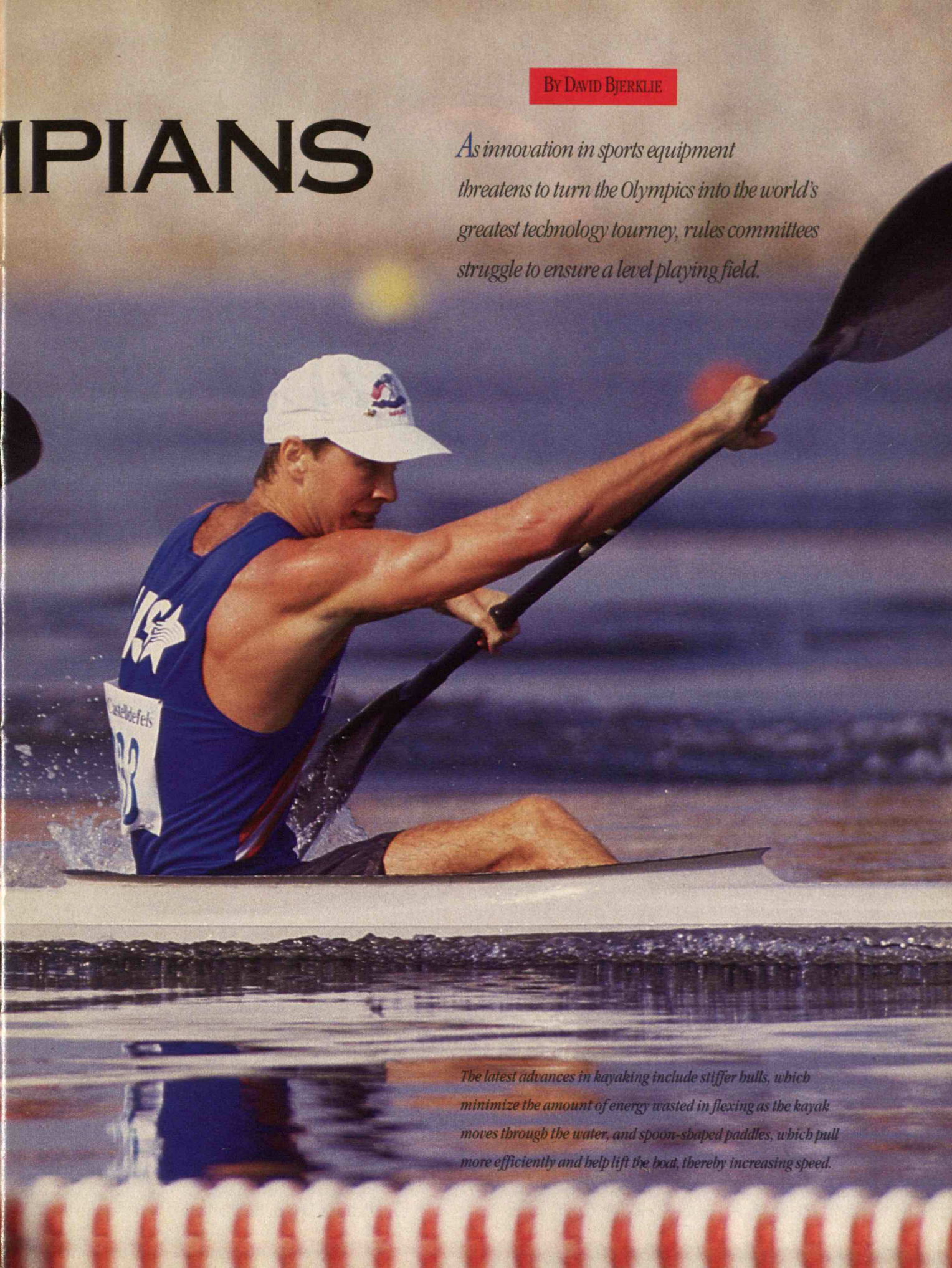


PHOTO: SPORTS ILLUSTRATED/ RONALD C. MODRA

MPIANS

By David Bjerklie

As innovation in sports equipment threatens to turn the Olympics into the world's greatest technology tourney, rules committees struggle to ensure a level playing field.



The latest advances in kayaking include stiffer hulls, which minimize the amount of energy wasted in flexing as the kayak moves through the water, and spoon-shaped paddles, which pull more efficiently and help lift the boat, thereby increasing speed.

THE thrill of victory and the agony of defeat may be unchanged since the first Olympics, but competition sports equipment undergoes constant technological improvement. Whether bicycles, kayaks, javelins, barbells, archery gear, or fencing swords, just to cite a few, the tools of the athlete's trade are now lighter, stronger, and better designed than even a few years ago.

In fact, sports equipment is so good that it raises some troublesome questions. Should attempts to advance the technology of sports equipment be a wide-open race to "build the best"? Should such equipment be allowed to drive world records? Or must rigid standards be imposed to ensure fair competition? "In theory," says Chester Kyle, a designer of bicycles and clothing for the 1984 U.S. Olympic cycling team, "you want a contest between athletes, not machines, but in practice it doesn't work that way."

From Boards to Bars

Many of the most dramatic improvements in sports equipment came on the heels of World War II. Diving springboards, for example, were transformed by way of the aircraft industry when Norman Buck introduced a design in 1948 that used 300 interlocking pieces of war-surplus square aluminum tubing. The "Buckboard" soon gave way to designs that used even stronger and lighter aluminum alloys. By the 1960s the enhanced springiness of diving boards made possible dives at the 1-meter height that had previously been performed only at 3 meters.

Today's boards are springier still and provide 15 percent more lift than those of the 1960s. They also feature superior non-skid surfaces, and the light weight and resiliency of the board tip minimize injuries, especially to the head. In fact, the last two feet of the springboard now weigh less than 10 pounds.

Pole vaulting also got a boost from improved materials. In 1960 Herb Jencks, manufacturer of fiberglass fishing poles, had just built a new deep-sea fishing rod 10-feet long and more than an inch in diameter. Jencks's son, a junior-high-school vaulter, borrowed one of his father's poles for a practice vault and, much to his surprise and delight, surpassed his personal best by half a foot.

Until then, pole vaulters used bamboo poles and landed in sawdust pits, and the world record was 15 feet. Today the world record is just over 20 feet, thanks to carbon composite poles that are custom built to the vaulter's weight, take-off speed, and hold technique. Foam-rubber pits that cushion falls more effectively also allow vaulters to be evermore fearless in their quest for height.

Before javelins (above) were "de-engineered," aerodynamic models were so advanced that they were being thrown off the field of competition into the stands. Today's pole vaulters use springy carbon-composite poles (right) to lift them to unprecedented heights.

Safety has clearly been the force behind improvements in fencing technology. Epee and foil weapons must now be made from maraging steel, a jet-fighter alloy that is stronger and less brittle than conventional carbon steel, according to Dan DeChaine, armorer for the 1992 U.S. Olympic team and member of the technical commission for the international fencing federation. The most dangerous situations in fencing arise when blades break in the heat of competition and puncture the fencers' protective garments. While 50 to 100 carbon blades typically snap in a world-class meet, only 3 maraging steel blades broke in the last world championship.

Safety standards for clothing have also been made more stringent. Fencing jackets and bibs—now made of Kevlar, a flexible synthetic fiber that is stronger than steel—are essentially bulletproof. Partly in response to the Soviet fencer who was killed in 1982 when his mask was pierced by a broken blade, masks are now constructed of stainless steel with a thicker mesh and denser weave that can withstand twice the force of the standard puncture test.

Archery bows made from new materials are a far cry from the sleek wooden relics that were still standard less than 30 years ago. In the mid-1980s Hoyt Archery introduced the latest in a series of materials innovations, a take-apart bow with a core made of syntactic foam—a material composed of tiny glass beads embedded in a rigid foam matrix—and wrapped in layers of carbon fibers and fiberglass.

The Hoyt bow is lighter and more stable than wood-core bows and is impervious to temperature changes, says archer and equipment expert Donald Rabska of Easton, which now owns Hoyt. "With wood you eventually get flex fatigue in the fibers," he says, "and no matter what you put on it, wood absorbs moisture and is affected by temperature changes." This means that wood bows shoot fast in cold weather but get mushy

DAVID BJERKLIE is a science writer for Time *magazine.*

PHOTOS: SPORTS ILLUSTRATED/HEINZ KLUETMEIER; PETER READ MILLER


USA
NIKE

Unlike their wooden ancestors, modern fiberglass bows are impervious to temperature changes and thus more consistent. Stabilizing antennas improve accuracy by absorbing vibration.

when the temperature rises. Rabska says the lightweight synthetic material also provides a speed boost: "Foam-core returns more of the release energy stored in the bow when the archer pulls back on the string."

Bow strings and arrows have also been transformed. Originally made of linen, strings are now made of a lightweight and low-stretch polyethylene that provides a velocity gain to arrows of several feet per second. The latest arrows—made from hollow aluminum with walls only .006 inch thick—are the lightest and therefore fastest yet. In fact, "they are about 20 feet per second faster than the all-aluminum arrows that were standard until the mid-1980s," says Rabska.

Such design changes have sent winning scores soaring. In a competition round, archers shoot a total of 144 arrows aiming for a perfect score of 1,440. Thirty years ago winning scores in major international tournaments hovered in the 1,100s. To win today, an archer must shoot in the neighborhood of 1,350.

Even the lowly discus, traditionally made of wood with its weight concentrated in a metal hockey-puck center, has been re-engineered. In the 1960s manufacturers began to experiment with different materials and weight distributions, hollowing out the wood rim and then replacing the hollow wood with a plastic shell. Designers then lined the edges with lead weights, distributing the weight nearer to the perimeter. "The theory," says Jay Silvester, chair of the U.S. discus development committee and former world-record holder in the sport, "is that weighting the edge stabilizes the discus in flight, which translates into longer throws." Certainly the numbers don't argue against the change. While Silvester set the world mark at 60.56 meters in 1961, the current record, set in 1986 by Jurgen Schult of East Germany, stands at 74.08 meters.

Barbells, too, have been improved. The newest bars are made from "clockspring steel" that is so flexible it can be bent nearly into a U and still resume its shape. "Lifters can take advantage of this," explains Lyn Jones, a coach of the U.S. Olympic weight-lifting team, "by timing the 'whip' of the barbells. Because the ends of the bar are momentarily lower when the center is jerked to chest height, the lifter can wait until the ends swing back upward to complete the lift.

Another innovation is a nylon sleeve that fits around the bar. Because the bar can rotate freely within the sleeve, the lifter can maintain balance and grip more easily while snapping the wrists under the tremendous strain.

Even the weights are better today. Since the 1972 Olympics, weights have been encased in rubber so that lifters could drop the barbell to the floor without causing damage. Having to lower it carefully wastes precious reserves of strength that are needed on the next lift.

Wavering Committees

In the early 1980s a study by the U.S. Olympic Committee (USOC) found that American athletes earned more medals in low-tech sports such as running and swimming than in high-tech sports such as kayaking and cycling. "It seemed paradoxical," says Eric Haught, chair of the sports science and technology commission of the U.S. canoe and kayak team, "that one of the most technologically advanced nations in the world performed worst in just those events in which it would be expected to excel." In an effort to close the technology gap, the USOC formed the Sports Equipment and Technology Committee (SETC) and enlisted researchers throughout the country to improve the quality of equipment available to U.S. athletes.

For example, Haught, an engineer who specializes in fluid flow, and Edward Van Dusen, president of Composite Engineering, received SETC grants in 1985 to perform extensive hydrodynamic testing of "slender body" forms such as kayaks and racing shells. From that research they designed a kayak with a more rigid body, which Greg Barton and Norm Bellingham paddled to gold medals at the 1987 world championships and Pan American games and then used to win two gold medals at the 1988 Olympics in Seoul.

Competition kayaks, once made of mahogany veneers, are now constructed of a combination of carbon-fiber cloth, Kevlar, and high-temperature epoxies—a stiffer design that minimizes the amount of energy wasted in flexing as the hull moves through the water. The hulls are also much lighter, but because there is a

PHOTO: SPORTS ILLUSTRATED/JOHN McDONOUGH

minimum weight requirement in competition kayaks, the weight saving is applied to new features such as reinforced foot braces and seat supports. These enable the athlete to sit in a position that is ideal for both mechanics and comfort, explains Haught.

Paddles, once made of solid poplar or birch, are now constructed of high-tech composites and weigh only half as much. Even more significant is a new spoon-shaped "wing" paddle that pulls more efficiently and achieves lift, thereby increasing speed. This design has required changes in paddling techniques, but the results have been so dramatic that all world-class kayakers now use it. "The wing was a revolution," says Haught, who estimates that the paddle has trimmed several seconds off world-record times.

Today work continues on the hydrodynamics of slender bodies. "We basically run races on the computer and see which design performs better," says Norman Doelling, assistant director of the Sea Grant Program at MIT.

But even when science and engineering come together in a dazzling new boat design, there is no guarantee that it will be embraced by rules committees. What's worse, explains Haught, is that you can't prequalify a boat. Kayaking officials believe it wouldn't be fair to approve a new design in secrecy, away from competitors' eyes, so they specify that boats have to pass inspection at the race. A team might decide to surprise the competition with a new design, he says, but the committee may throw the boat out of the contest right at the meet.

When it comes to run-ins with the rules, bicycle racing is in a class by itself. The sport has a long history of technological improvements and an equally long history of ambivalence over them. For example, in 1911 the French designer Etaine Boneau Varilla patented an enclosed bike that resembled a mini-dirigible on wheels, which indeed did "fly" past competitors. But by 1914 the international cycling federation decided that it was in the best interest of the sport to ban features added to a bike solely for streamlining. Bicycle design has been a game of hopscotch

Once designed with its weight concentrated in a metal hockey-puck center, the discus is now lined with lead around the perimeter. This improves stability in flight, which translates into longer throws.

PHOTO: SPORTS ILLUSTRATED/PETER READ MILLER

Fencers concentrate on technique rather than worry about injury—thanks to tough new metal alloy blades, which are nearly unbreakable, and new protective garment fabrics, which are essentially bulletproof.

between engineers and cycling-federation officials ever since.

In 1932 French engineer Charles Mochet designed the recumbent bike, a low-slung affair in which the cyclist reclines and pedals as if in a Barcalounger. The bike used a rider's leg and lower-body strength more effectively than did an upright bike. "Even when piloted by second-rate cyclists," says bike designer Chester Kyle, "Mochet's bike beat every cyclist in Europe and also promptly set a new world record for the distance covered in an hour." Just as promptly, the authorities outlawed the revolutionary new bike from all official competition. The recumbent, the ruling body declared, was not a bike at all.

Kyle's own designs for cycling equipment have been outlawed eight times. "But the federation seems to waver back and forth in its interpretation of the rules," he maintains—a feature that is declared illegal one year may become the legal standard the following year.

For example, in 1984 Francesco Moser, an Italian bike racer, broke what wheel designer Steven Hed refers to as "the Babe Ruth home-run record of cycling." Moser covered more than 50 kilometers in one hour, surpassing the mark set in 1972 by Belgian cycling great Eddy Merckx, the most successful professional racing cyclist of the modern era. Moser accomplished this feat riding a custom bike—crafted by Antonio Delmonte, designer and physiologist for the Italian national team—featuring wheels in which the spokes had been replaced with a thin but rigid disk that supported the tire rim.

Disk wheels were suddenly hot. Moser's were priced at $6,000, but European manufacturers were soon selling them at a discounted but still stiff $1,200. In 1984 both the U.S. and Italian teams battled the international cycling federation, arguing that disk wheels should be allowed into Olympic competition. When the cycling authorities eventually relented, Italy and the United States cleaned up: the United States earned nine medals, its first since 1907.

Disk wheels have a drawback: they can be tough to control in crosswinds. The best solution often proves to be a bike with a rear disk wheel and a conventional front wheel, especially since designers like Hed, whose wheels rolled bikes from 10 countries at Barcelona last summer, have further refined the performance of the front wheel. The designers have cut drag by reducing the number of spokes and flattening the remaining few into thin blades that slice through the air. The rim has also been made more aerodynamic with a new egg-shaped cross section.

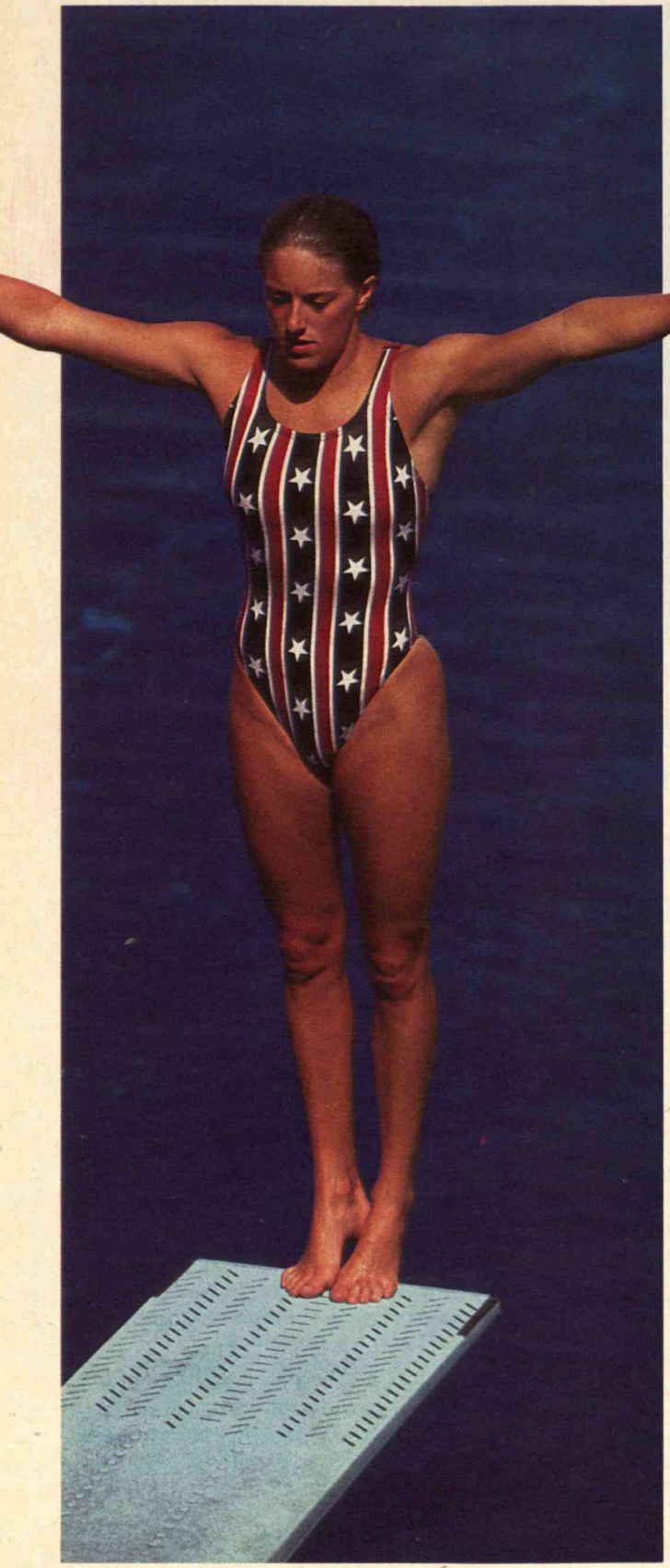
An even more significant innovation is the aero handlebar. Because it extends far over the front wheel with the hand grips close together, the aero bar forces the rider's body into a low forward tuck with arms extended almost prayer-like. "It's one of the biggest technological innovations since the beginning of the bicycle," Hed claims. The aero bar was developed by former U.S. ski-team coach Boone Lennon, who brought downhill skiing and wind tunnel experience to his enthusiasm for bike racing. The bars were first used by triathletes but really caught on when Greg LeMond used them to win the 1989 Tour de France. "In a 25-mile time trial," says Hed, "aero bars probably make a three-minute difference. In these events, if you don't have aero bars, you don't have a chance."

Bicycle engineering innovations don't end with hardware. Helmets are tear-drop shaped, visored, and vented to eliminate turbulence and are form-fitting, thanks to an inflatable bladder that can be pumped up to desired firmness. And new suits made of breathable nylon with silicone ribbing on the back and shoulders smooth out wind turbulence by helping air follow the natural contours of the cyclist's body.

Air resistance, in fact, is the barrier against which cyclists expend 90 percent of their energy. "What's most important is the turbulence created in the rider's wake—it's like an invisible hand holding the rider back," says John Sipay, former manager of team support for the U.S. Cycling Federation. Installing a fairing, or smooth wraparound structure that

When springy aluminum-alloy diving boards were first introduced, they enabled dives previously unimaginable—and for which degree-of-difficulty had not yet been calculated.

PHOTO: SPORTS ILLUSTRATED/RICHARD MACKSON



reduces air resistance, behind the seat could clean up 20 percent of that swirling turbulence, he says.

However, what's clearly illegal, says Chester Kyle, "is when things are done for streamlining purposes only." Everything on the frame has to be a functional part of that frame. The dodge, therefore, is to try to make the fairing part of the structure, not an add-on. In fact, already on the drawing board for the 1996 Olympics in Atlanta are designs that make a seat fairing "an integral part of the bicycle."

Gipay, for one, believes that the sky should be the limit when it comes to technical improvements in cycling. "In the world of auto racing, no one believes we should still be racing Model T's, do they?"

Selecting for Athletes

The actual consensus, at least in principle, is that sport should remain a contest between athletes, not machines. But we need to be aware, says Haught, that changes in the rules governing equipment can determine who will excel. "Why do elite rowers stand 6 feet 4 inches to 6 feet 6 inches tall and weigh about 210 pounds," he asks, "while elite kayakers stand 5 feet 10 inches to 6-feet tall and weigh 180 pounds?" The reason is found in the allowable boat dimensions: a rowing shell can be as long as boat designers desire, whereas the length of competition kayaks is strictly limited.

In a rowing shell, stronger is better, even at the expense of added weight, because longer boats can distribute more weight over a larger area without riding low in the water and thus creating excessive drag. Performance in a kayak, however, says Haught, is more dependent on an ideal "aerobic strength-to-weight ratio." At a certain point, added bulk is a disadvantage despite any increase in strength that a heavier paddler can bring to the race.

This important consideration applies to nearly every sport: change the equipment—make it lighter, faster, stronger—and you change the athlete. Or more accurately, you select for athletes who possess the traits that are able to maximize the performance of the new and improved equipment.

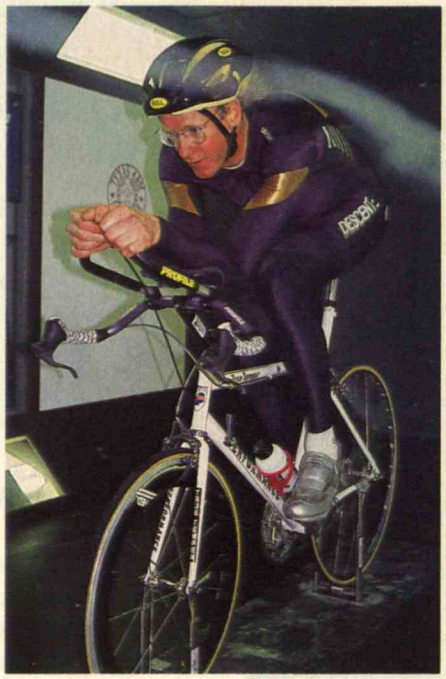
Take the javelin. When it was redesigned to be lighter and possess a more aerodynamic taper and center of gravity, athletes accordingly honed their technique to make the javelin sail. "If thrown at exactly the right angle, velocity, and orientation," explains Mont Hubbard, a professor of mechanical engineering at the University of California-Davis who applies computer modeling to sports, "the aerodynamic javelin would achieve a powerful lift, floating with its nose up even as it passed its zenith and began to descend back to earth. If all went

PHOTO: SPORTS ILLUSTRATED/RONALD C. MODRA

right, the javelin would dip nose downward only at the very end of its trajectory."

The technique required a great deal of finesse, but those who mastered it staggered the competition. In 1983, American Tom Petranoff broke the world record by three meters with a stunning 99.72-meter toss. Then just days before the 1984 Olympics Uwe Hohn of East Germany smashed Petranoff's world record by five meters with a soaring 104.80-meter throw.

Unfortunately, this match of exquisitely refined spear and perfect technique was rendering the world's sports stadiums obsolete—not to mention endangering spectators and other athletes warming up on the far side of the track. Javelins were being thrown out of the field of competition, and what's more, says Hubbard, they had a nasty habit of veering sharply to either side if misthrown. The sport's rules committee responded in 1986 by banning the new design. With the new de-engineered model, the world record dropped precipitously by 20 meters. And as the finesse throwers suddenly faded into the second ranks, the strong arms of power throwers once again prevailed.



Wind tunnel tests show how teardrop-shaped helmets and ribbed skin suits can smooth out turbulence, which normally holds back the rider like an invisible hand.

Popularizing the Sport

Today the highest priority among rules committee officials is to keep their sport affordable to many athletes. "It's not fair to compete on one-of-a-kind designs," says John Tarbert, technical director and effectively keeper of the rules for the U.S. Cycling Federation. For instance, disk wheels were initially banned from Olympic competition because they were so expensive they really couldn't be considered "available" to most cyclists, he says.

Andy Toro, a former bronze medalist who now sits on the board of the International Canoe Federation (which oversees both canoe and kayak competition), wrestled with this very issue at a committee meeting last October in Madrid following the summer Olympics. On the agenda were several proposals that called for all canoes and kayaks to conform to a single hull design.

Toro supported the concept in theory. "Our sport is considered expensive, and we run the risk of pricing ourselves out of existence if we let the technological race continue wide open," he says, pointing out that new designs using exotic materials cost some $3,000 each. Costs must be reduced before the sport can be expanded internationally, he notes; for example, only three African countries are currently competing.

But Toro spoke out against the specific proposals because of concerns that the owner of the chosen design would suddenly have a monopoly. His proposed solution was to allow technological improvements, but at a slower pace: "I think we can establish a standard that we can review every four years and change if necessary to accommodate development."

The Federation of International Target Archery devised a similar approach—also to introduce competition archery into less affluent countries—that appears to satisfy both the conservative and progressive factions in the sport. Four years ago the federation established a "standard round" in international competition, in which the bows, strings, and arrows that can be used are all carefully specified. "It's very good equipment, but not the top end of cost and technology," explains Easton's Donald Rabska.

Part of the reason for the success of the standard round is that "there are a lot of archers who just don't want to futz with the cost and the latest technology," Rabska says, but at the same time an open competition challenges competitors who shoot the latest equipment, such as bows that use pulleys to amplify the archer's pull strength. By allowing competition at different equipment levels, archery resembles car racing, which has managed to fuel competition along a broad spectrum of equipment ranging from stock cars to formula-one racers.

Some observers argue that the goal should be to keep a sport alive for athletes and fans—not to mention manufacturers—by encouraging rapid technical innovation. But when push comes to shove, rules committees seem to place popularizing the sport first. As Haught says, "The more children you can put into boats, the more chances you have for an Olympic champion."■

PHOTO: FRED ZAHRADNIK

The world's smallest 12-band receiver.

Includes digital clock, travel alarm, headphones, deluxe travel pouch, three "AA" batteries, and Grundig guide book. Measures approximately 3½" x 5⅝" x 1¼" and weighs a mere *14 ounces!*

The world is at your fingertips with...

The Grundig World Band Receiver

Announcing a revolutionary breakthrough in world-band radios...from Grundig, the leader in German shortwave electronics. This miracle of miniaturization is not sold in U.S. stores or catalogs—only Willabee & Ward has it!

Tune in to events around the globe.

The RK-709 is the world's smallest 12-band receiver—AM, FM, FM Stereo (with headphones, included), and *all* 9 major shortwave bands. Small enough to fit into a pocket, briefcase, or purse, yet big on features. Telescoping antenna pulls signals from anywhere in the world. Listen to legendary BBC newscasts—the best in the world. Hear what Radio Moscow is saying about Yeltsin, or the American elections. Listen to the Voice of America for news from home when you travel abroad. Follow a crisis or breaking story wherever you are and no matter where it's happening: Baghdad, Barcelona or Beijing.

You don't have to pack a travel alarm, either.

You won't need it—this is better. The RK-709 wakes you with the radio or its ingenious "Humane Wake System"—the tone begins softly and gathers volume until you wake up! The digital alarm clock features a sleep timer that turns off the radio 10 to 60 minutes after you turn in!

Only $159!
Payable in monthly installments.

The Grundig RK-709 is only $159 (plus $7.50 shipping/handling), payable in convenient monthly credit card installments. Includes deluxe carrying pouch, three "AA" batteries, and stereo headphones. One year warranty, 30 day money back guarantee. Order today.

Don't be confused by other 4, 5, 7, or 9 band radios. Grundig's RK-709 is today's best buy on a real 12 band receiver.

CALL TOLL-FREE: 1-800-367-4534 Ext. 623-290

Willabee & Ward
47 Richards Avenue
Norwalk, Conn. 06857

Satisfaction guaranteed.

CALL TOLL-FREE: 1-800-367-4534
Ext. 623-290

Please send me ____ Grundig RK-709 World Band Receiver(s). For each receiver, charge 4 installments of $41.63* to my credit card:

☐ MasterCard ☐ VISA
☐ Discover ☐ Am. Ex.

Credit Card # Exp. Date

Name
PLEASE PRINT CLEARLY

Address

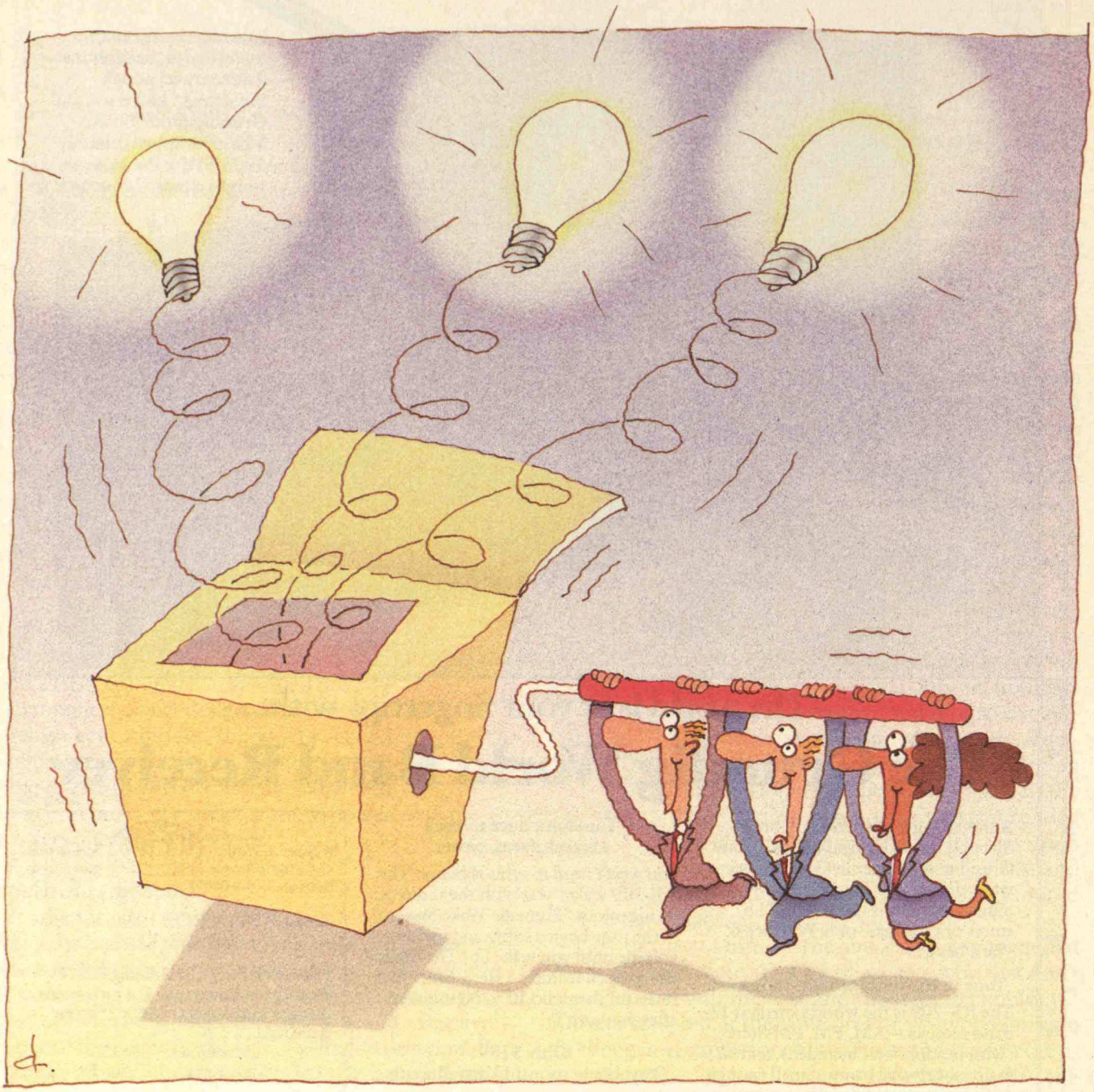
City/State/Zip

Signature
(All orders subject to acceptance.)

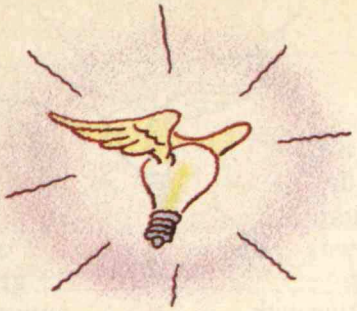
☐ I prefer not to pay by credit card and will pay by check. Enclosed is my check for $159* plus $7.50 shipping/handling, a total of $166.50 for each receiver.

*Any applicable sales tax will be billed with shipment.

Phone orders normally shipped next business day.
Higher shipping/handling outside U.S.



The Idea Makers



By Thomas Kiely

EMPLOYEES of Du Pont use dreams and metaphors to solve manufacturing problems and develop new products. At Eastman Kodak, Hoechst Celanese, and Amoco, scientists and engineers shake up their thinking with imagination-enhancing games that would have been familiar to surrealist artists in the 1920s. Managers at Texas Utilities, a Dallas-based power company, solve an expensive capital planning problem by imagining themselves as a kilowatt traveling through the company's systems.

Fantasy, games, and dream analysis are the kind of inspiration-kindling strategies that poets might practice in their search for novel expressions. But these are just a few of the creativity techniques used by employees at a growing number of companies. Managers promoting use of these activities hope to spark creative thinking throughout the corporate ranks, from maintenance workers to CEOs. Ultimately, they see creativity as a means to enhance quality, performance, and innovation within the company.

"Employing creative people is necessary in today's competitive world, but absolutely not sufficient," says Sheldon Buckler, vice-chairman of Polaroid, in Cambridge, Mass. "You also need an environment that values and encourages what employees do, and they need tools to help them to keep renewing creativity. That is what creativity techniques do."

Some companies have plunged headlong into creativity training. Frito-Lay, a subsidiary of PepsiCo, trained all 25,000 of its employees during the 1980s, Corning trained 26,000 employees in several countries, and Exxon has trained nearly 7,000 employees in its sales, exploration, and chemicals divisions since 1988. Texas Utilities trained its top 400 executives to use an array of creative thinking techniques, and is now offering similar instruction to other employees. In fact, more than one-fourth of all U.S. companies employing more than 100 people offer some kind of creativity training to employees, according to surveys conducted by *Training* magazine, a Minneapolis-based trade publication.

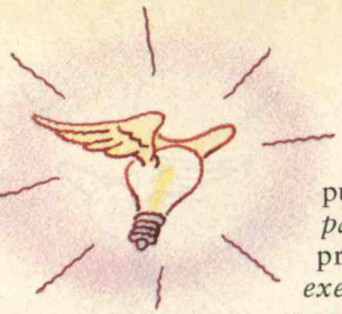
Games? Dreams? "Brainwriting"? Is this any way to foster creativity? A growing number of U.S. companies think so, and have results to show for it.

Despite this growing popularity, some critics dismiss creativity training as a flaky management fad. There is a danger, they say, that managers will apply these methods as Band-Aids for problems that require more serious attention. Moreover, critics charge, the focus on generating new ideas misses the point of what is really wrong with most businesses. "Ideas come rather easily," says Thomas Kuczmarski, president of Kuczmarski & Associates, a Chicago-based innovation consulting firm. "The real problem companies face is in transforming those ideas into products"—and that bespeaks organizational obstacles, not deficient thinking skills.

Even most proponents of creativity training agree that invention—coming up with a new idea—is only the first step. The real goal is innovation—in other words, turning an idea into something of value to the business. But they contend that creativity techniques help prime the idea pump and coax employees to strive for the original and the unexpected. Moreover, innovation is not just the business of new-product or marketing departments. Companies like Du Pont and Kodak want assembly line workers to discover novel solutions to shop floor problems; want sales employees to think up new ways to woo customers when tried approaches fail; and want managers to gain insight into how they budget, plan, and strategize.

At Kodak, for example, maintenance workers used a creativity technique to reinvent the way they tend a film-processing machine. The machine, which is the size of a football field and is used to

ILLUSTRATIONS: JACK DESROCHER



deposit the emulsion coating on photographic film, must be shut down periodically for preventive maintenance and for capital improvements. Too often, these shutdowns had occurred during large production runs.

A dozen maintenance employees, working with one of the corporation's creativity trainers, imagined that they were at a party, celebrating their ability to reduce the job from seven days to four without interrupting production runs. They imagined who was at the party and what was said—and began to draw out real solutions from the imagined party banter. By standing the problem on its sequential head, the team looked at the dilemma from a fresh perspective. Ultimately, they refined their ideas (which included developing modular equipment and making creative use of production schedules) and successfully completed their charge.

While creativity techniques won't create an organization full of Picassos and Edisons, these thinking methods do nudge people to stretch beyond the familiar. Du Pont, for instance, was searching for additional markets for fire-resistant Nomex fibers, which the company sold for use in protective clothing worn by firefighters. There was one problem: the fiber's tight structure was impervious to dyes. Potential customers (it could be used in the interior of aircraft) would not buy the material unless Du Pont could manufacture a version that could be colored at a reasonable cost.

A solution eluded researchers—until one scientist, who had been taught creativity techniques, began to dabble with a problem-solving method called metaphoric thinking. The idea, says Charles Prather, director of Du Pont's Center for Creativity and Innovation, is to liken a problem to processes that are completely unrelated; the mind then leaps to make connections, occasionally discovering something clever along the way.

The Du Pont scientist, who grew up in coal country in West Virginia, compared his problem to a mine shaft. To excavate minerals, miners dig a hole into the earth and use props to keep the hole from collapsing. Expanding on the idea, the researcher figured out a way to chemically prop open a hole in the Nomex structure as the material is being manufactured so it could later be filled with dyes.

The Many Paths to Creativity

Most of the creativity techniques being used in business fall into one of four groupings: *Fluency* techniques help stimulate the generation of ideas; *excursion* sessions push the mind to grope for illuminations; *pattern breakers* force thinkers to restate problems in novel ways; and *shake-up exercises* (such as games) help loosen up groups and make them more receptive to unusual ideas.

Fluency techniques are the simplest and most widely used. Creativity proponents claim that fluency techniques help individuals or teams develop flexible habits of mind, and suspend judgment and analysis in favor of sheer flow of ideas.

One of the most formidable barriers to creativity is criticism. The possibility that the boss or colleagues will attack an idea inhibits employees from offering their thoughts—especially novel ones. And managers do often focus so intently upon the flaws of an employee suggestion or new product idea that they lose sight of the potential, says Robert Johnston, a partner at IdeaScope, an innovation consulting firm in Cambridge, Mass. Creativity, says John Seeley Brown, director of the Xerox Palo Alto Research Center (PARC), demands openness, interaction, and collaboration, a willingness to try to bridge differences in disciplines and methodologies, and a willingness to listen for glimmerings of useful ideas, however raw.

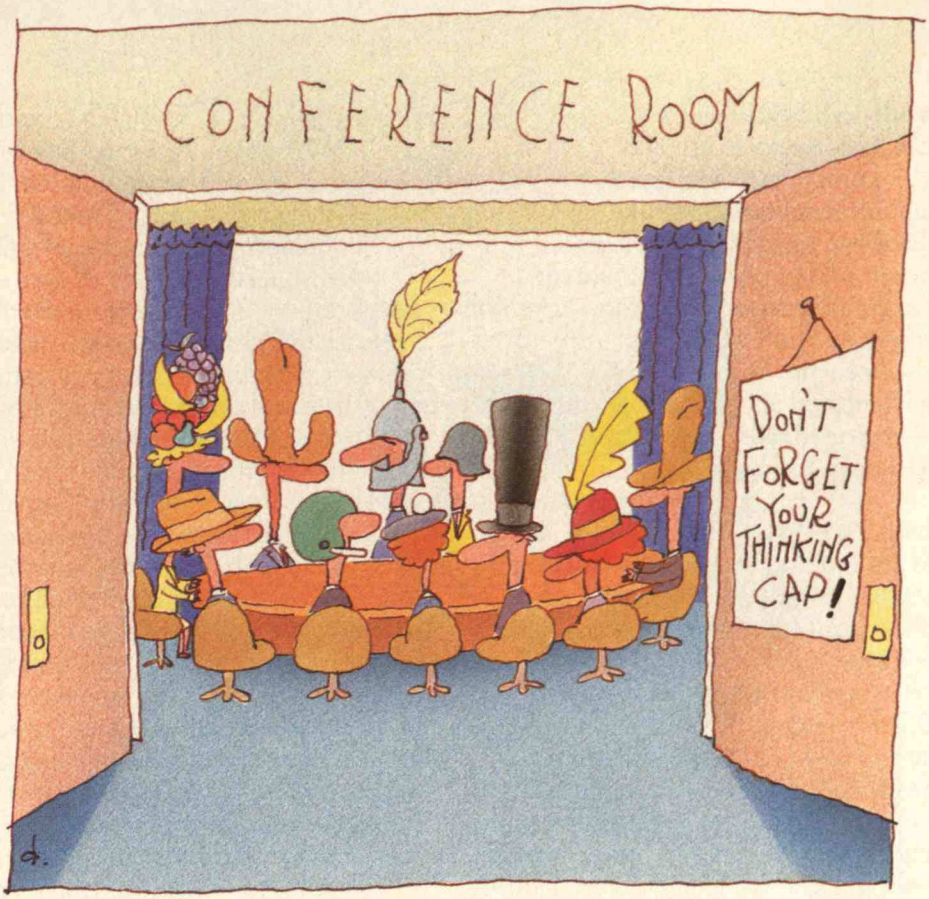
This insight underlies the oldest fluency technique—brainstorming. Developed by creativity guru Alex Osborn in 1938, brainstorming has become primarily a group activity in which participants fire off as many ideas as possible. The premise is that a group will produce a far greater number of ideas, from different perspectives, than an individual can. In an ideal brainstorming session, all thoughts are treated as welcome guests; judgment is deferred. Criticism is forbidden until afterward, when ideas are evaluated and prioritized.

Unfortunately, brainstorming rarely achieves its nonjudgmental ideal. In fact, most creativity consultants and many companies have abandoned brainstorming as ineffective. The Center for Creative Leadership (CCL), a management research and consulting organization in Greensboro, N.C., has found that there is often little difference between the production of ideas by individuals and teams.

"There are a lot of pressures that inhibit group performance," explains Jim Shields, manager of innovation programs and products at CCL. Brainstorming sessions can be undercut by group uniformity pressures and perceived threats from senior managers in attendance, he says. Personality differences also come into play; some people are naturally willing to talk, while others tend to remain silent, and the best ideas do not necessarily come from the loudest people, he points out.

To avoid the shortcomings of brainstorming, some

THOMAS KIELY is a senior writer for CIO, *a technology management magazine for chief information officers and other corporate executives.*



Managers are promoting role-playing games and other inspiration-kindling strategies to spark creative thinking throughout the corporate ranks.

companies have adopted instead the fluency technique called brainwriting. During a group brainwriting session, employees write down their ideas on slips of paper, usually in a manner that protects their anonymity. Then they exchange papers and try to build upon each others' insights. That way the loudest voices don't necessarily prevail, and employees feel less pressure to perform for the boss.

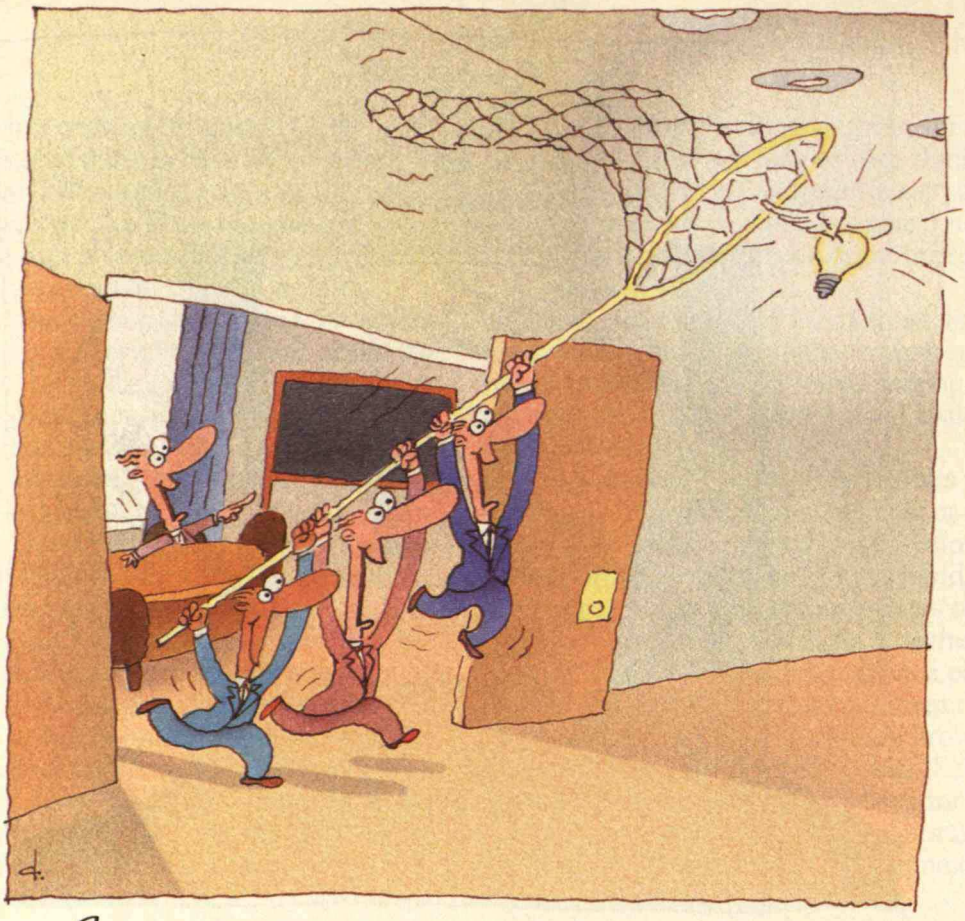
"Brainwriting is popular with scientists and researchers," says Jeff Felberg, director of Amoco Chemical's New Ideas Process, a program to foster new business development. "They tend to judge ideas strongly. Brainwriting helps get them beyond self-censorship."

Brainwriting can be easily adapted to work over a computer network. Employees at Electronic Data Systems, the computer systems management arm of General Motors, maintain automated brainwriting facilities in Cambridge, Mass., and Ann Arbor, Mich. The facilities include a bank of networked Macintosh computers occupying the conference table. Brainwriters type their thoughts anonymously into the network, then consolidate ideas onto a "public" computer screen that all can view together.

Two other fluency techniques are mind-mapping and storyboarding—both methods for visualizing ideas and associations. With mind-mapping, individuals or groups draw a primary idea in the center of the paper, then depict new or related ideas as vines growing in all directions. "It's an organized brainstorming method," says Michael Stanley, a logistics engineering manager at Boeing. "Without mind maps we could get lost in the minutia."

Boeing engineers have used mind maps to get a better understanding of the internal process for developing technical manuals—and to pinpoint ways to improve work flow by eliminating redundancies. They also used a mind map to explain quickly and cogently to a customer a complicated maintenance program for a Boeing-made weapon system. In both instances, says Stanley, mind maps proved an effective way to condense a lot of information into a single image.

With storyboarding, participants in a group jot ideas down on index cards, which are then displayed on large bulletin boards or conference room walls. This technique is especially handy for thinking about processes.



Coming up with a new idea is only the first step. The real goal is innovation—turning an idea into something of value to the business.

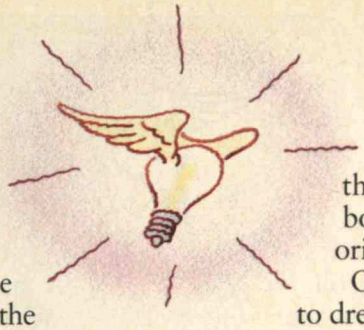
Each step in a process is a frame in a narrative. Employees readily reshuffle, rewrite, or even eliminate cards, with an eye toward improving the efficiency of the flow.

Allstate Business Insurance, General Electric, and Bell Atlantic all use variations of storyboarding. At Xerox PARC, researchers sketch ideas onto a large white wall in a common area, opening up a discussion of their ideas to other researchers from all disciplines. The technique invites group commentary and multiple perspectives, all of which can be considered and reconsidered over time. At Bell Atlantic, departments hang large swaths of brown wrapping paper up on hallway or conference room walls. Employees use pens, markers, and post-its to change the diagram, adding boxes and arrows and an abundance of comments. The group slowly redesigns a process, such as how to move an idea from laboratory to market.

Walks on the Wild Side

Techniques such as storyboarding and brainwriting, while useful, often help people hatch more or less conventional ideas. Fluency techniques "are like business trips," says CCL's Shields: "They are goal focused, straight line, efficient, and usually predictable." A second set of thinking stimuli, by contrast, inspire employees to crawl out onto mental limbs. These "excursions," Shields says, are "wandering, unpredictable, novel." Excursion techniques take the individual or group away from the problem so that the unconscious can work on it from a different perspective—metaphoric and nonsequential—and then prompt the imagination to pull out ideas.

One excursion technique, called a forced relationship, works this two-cycle magic using a wholly unrelated stimulus such as photographs, objects, or paintings. This past summer, for instance, a group of Polaroid managers from various departments (including sales, design, research, manufacturing, and marketing) met to seek ways to better mesh different functions. The company's senior creativity specialist, Suzanne Merritt, asked the managers to look at a couple of paintings and describe what they saw. Merritt then asked the managers to force-fit their impressions from the paintings—which she picked at random from a large collection—to their original task of figuring out how to improve inter-



departmental harmony.

One painting showed crows in a tree beside a fish-populated pool of water. To some in the group, it seemed as though the fish were vainly trying to communicate to the unhearing birds—and as they discussed this impression, both marketing and R&D realized that they saw themselves as the unheard fish. Researchers speak a technical language, preoccupied with scientific rather than commercial matters, marketers felt; while R&D believed that marketing was deaf to new technical insights. As a result of this meeting, teams of marketing and research employees will now meet quarterly to "learn how to talk to each other," Merritt says.

Randomly selected words can similarly serve as problem-solving stimuli. This technique is popular at meetings of the International Creative Forum, a consortium of companies (including IBM, Nestle, and Prudential Insurance) that use creativity techniques to meditate upon common business problems. At a forum gathering last spring, for instance, upper-middle managers from member companies tried to envision customer demands in the year 2000. The managers first discussed general demographic forecasts and market trends, then broke up into sub-groups to try to identify future opportunities.

One sub-group, looking at the aging population, used the word "window," randomly selected from a list of words to focus their thoughts. Seeing a senior citizen's mind as a window opening onto a landscape of desires, the group came up with a concept for a suite of services that would go directly to the customer to fulfill a variety of everyday needs—from taking out the garbage and delivering groceries, to paying bills and fixing the car.

Excursions can also be dreams. Three years ago, Floyd Ragsdale, a section engineer at Du Pont's polymers plant in Richmond, Va., was part of a team that had struggled for weeks to solve a problem with collapsing vacuum hoses at a fibers production facility. Trained to review his problem before dropping off to sleep, the engineer woke with an image of a child's slinky toy still vivid in his mind. He jotted down a note about his dream on a pad he kept beside the bed, then realized that the image suggested a remedy. The research team soon verified his dream-produced idea, which essentially was to strengthen the vacuum hoses by inserting slinky-like springs.

Despite its new-age flavor, the use of dreams to augment creative thought has a venerable history. The nineteenth century Flemish chemist August Kekulé dreamed of a snake biting its own tail—and realized he had found the ring-like molecular structure of benzene, a problem he had worked on for years. And the 1936 Nobel Prize–winning physiologist Otto Loewi claimed that his insight that the nerve impulse is both an electrical and a chemical process originated in a dream.

Other excursion techniques teach workers to dream while they are awake. By imagining themselves inside products or processes, for instance, employees use mental images summoned from the unconscious. A Du Pont researcher, trying to find ways to control colors in one product, visualized himself inside the material. He imagined light penetrating it and reflecting off individual particles—and saw a solution (which, for proprietary reasons, Du Pont won't yet disclose).

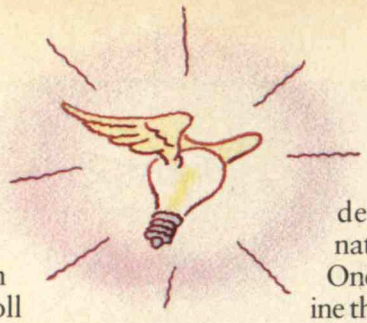
And Texas Utilities managers used a visualization technique to dramatically reduce the company's capital equipment costs. Huge power-generating machinery such as turbines, generators, and boilers have an average life expectancy of 35 years, says Texas Utilities executive vice-president Robert Gary; replacement costs for large equipment is typically $3,000–5,000 per kilowatt.

A team of managers, engaged in a three-month study to shave these costs, visualized itself as a kilowatt traveling through the company's various fossil fuel and nuclear power systems. As they imaginatively traveled through each stage of the process, they began to understand the complex and diverse levels of durability within systems—and saw a way to take advantage of it. Rather than continue to replace whole systems, they proposed, the company should adopt a maintenance plan that called for replacing key constituent parts. Gary claims that the redesigned maintenance plan will drive the company's equipment costs down tenfold or more during the decade ahead.

Stretching and Relaxing

A third set of techniques, known as pattern breakers, force the mind to stretch to find patterns between dissimilar concepts, in the hope of discovering unusual ideas in odd associations (a notion promulgated by surrealist poets and artists in the 1920s). The metaphorical thinking strategy that the Du Pont researcher used to find a way to make dyeable Nomex is one example of a pattern breaker.

Pattern breakers differ from excursion techniques in a subtle but important way. Excursion exercises are intended to take a person's mind away from a problem temporarily so the unconscious can mull it over. Metaphorical thinking and other pattern breakers, in contrast, keep the problem in focus but in a different light, jarring people out of their mental ruts and sparking fresh insights. The imagined party conjured up by Kodak maintenance workers is a good model of a pat-



tern-breaking exercise.

Other random stimuli also can be used. Synectics, a Cambridge, Mass., innovation consulting firm, asks clients to take a stroll with an instant film camera, and then uses the snapshots as prompts. One such client was a large management consulting firm trying to develop a program of services aimed at corporate R&D units. The camera-toting group returned to Synectics with images of a glass jar, a household wash product, and a Federal Express package, among others.

The picture of the glass jar, which was surrounded by colorful trinkets, led to a discussion about how to sell a service that seemed practical to the consultants who devised it but that was lost in a crowd of business services. The image of the Federal Express package prompted comments about how the package delivery company had concocted a successful business system (speedy delivery) that helps other business systems to work—a discussion that helped the consulting company to design a new service to help clients accelerate their R&D. As is the case with most pattern breakers, this activity is more goal-directed than an excursion exercise. Throughout the examination of the photos, participants kept their objective in mind and focused their comments accordingly.

Just as an open attitude toward new ideas and a taste for alternative solutions are preconditions for creativity, so are risk-taking and a willingness to "fail" or embarrass oneself. In the fourth class of creativity techniques—shake-up exercises—employees engage in games or team activities intended to help them relax, laugh, and fumble. "Humor breaks the self-censoring mechanism," says Jeffrey Mauzy, a principal at Synectics. "It's hard to come up with ideas; it's harder to say them. But when we're laughing, we're less inhibited."

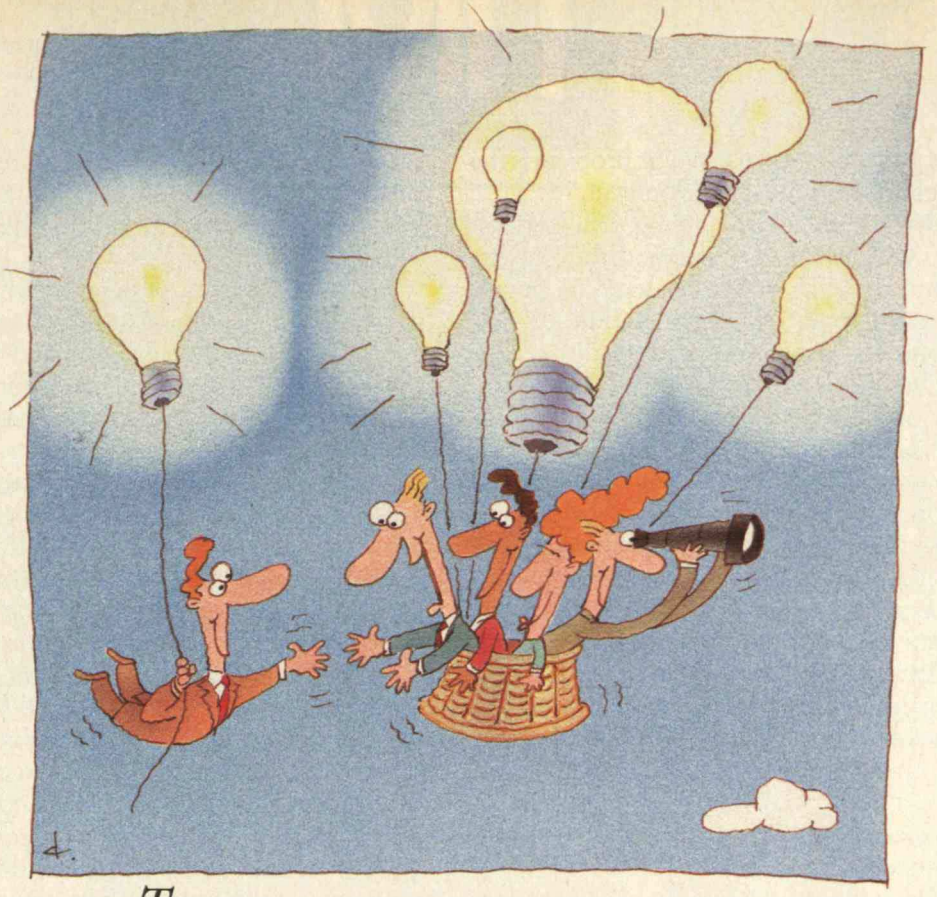
Companies like First Chicago bank have used role-playing games—replete with funny costumes—and outdoor activities to shake employees up. Ditto Kodak: Deborah Nicklaus, a creativity specialist from the company's management services department, has a collection of about 30 hats that she uses in relaxation games. She might ask a participant to don a Santa Claus cap and describe a proposed product from the point of view of Father Christmas: How could the company market the product to a customer who will use it only once a year? Will a camera capture an image using only the light from Rudolph's nose? Should it be able to work in the freezing temperatures of the North Pole? The point is not to actually devise a product or a marketing strategy but rather to loosen up the imagination in preparation for the business tasks at hand. Other shake-up exercises involve group fantasies: Invent a western town, or a city block, in detail; imagine suspending the laws of nature; create a product line for Napoleon. One Kodak game asks participants to imagine they are in a hot air balloon and to describe what they see behind them as the balloon carries them across an unknown landscape.

Kodak also maintains a "humor room" stocked with games, objects (such as toy robots and juggling balls) creativity books, and Monty Python videos. A financial planning group, working on new corporate performance measures, has used the humor room as a conference site. "People relax in the room, and open up," says group member Thomas Dabrowski. In one instance, the group convened to brainstorm how to measure the company's effectiveness in distributing goods to customers. Like most companies, Kodak monitors delivery time, distribution costs, and customer satisfaction. The group was seeking unconventional yardsticks that might provide new information to the company's top decision makers. Inspired by the humor room, Dabrowski says, the participants tossed out a few off-the-wall ideas, one of which eventually led to a new method for visualizing these costs and their relationships.

At Texas Utilities executives have invited children to participate in business meetings. In one of these sessions, the children—fifth and sixth graders recruited from a local school's gifted and talented program—listened as executives complained about time wasted in meetings. One little girl pointed out that the way they described meetings made them sound important. Maybe, she suggested, managers needed to use meetings differently rather than have fewer of them. Prodded by the children, the managers devised solutions that included a "buddy system" (for sharing meeting attendance) and the use of tape recordings.

Executives from other Dallas-area companies have done tours of duty in playgrounds. "We ask them to notice how kids play," explains Ann McGee-Cooper, a consultant who also helped to bring children into the company. "Kids discover, and when they tire of their own rules, they change them," she says. The executives then try to look at their own problems as games where the rules can be changed, where nothing is set and all alternatives are possible.

Groups will often use a combination of creativity techniques, depending on how experienced and tolerant of offbeat activities the participants are. "You can't go into a room with people and start up with excursion techniques," says Houston-based creativity consultant Rolf Smith, the former head of the U.S. Air Force Office of Innovation and a codeveloper of Exxon's innovation program. "They'll throw you out the door. It gets higher-value ideas, but it's loosey-goosey stuff. You have to start



True innovation requires an organization that is receptive to new ideas.

with the basics, then introduce these techniques slowly."

When a Du Pont creativity facilitator works with a research or business group, the day usually begins with a brainstorming session, which gets the usual thoughts out. In hindsight, these are usually the most commonplace ideas spawned that day. But "you have to allow people to get out the ideas they came to the meeting with—let them be heard and honored—before you can go on," says Du Pont creativity center director Prather. When the group exhausts its first wave of ideas, Prather says, "then we bring out the more advanced techniques, like forced relationships—and this brings on a new avalanche of ideas."

A Creative Culture

To some innovation experts, creativity training is loopy nonsense. "Creativity is not predictable, and it can't be measured," says management consultant and experimental psychologist Joseph Harless, president of the Atlanta-based Performance Guild. Many employees are uneasy with the exercises as well: "Some people see these creative experiences as something magical or mystical, or tied to mental illness," says innovation consultant Shields. "You can't ask people to do something that is uncomfortable for them."

Creativity researchers admit that the benefits of creativity training are hard to pin down. "We make assumptions that training works," says William Shephard, director of programs at the Creative Education Foundation in Buffalo, "but we don't know enough about it yet. All of this is still in its infancy." There is no definitive way to evaluate whether creativity training improves workplace performance; the "proof," such as it is, remains anecdotal. That is not enough for many executives. "Senior managers often say that creativity is alright for research or advertising or marketing but not for them," says Edward de Bono, an author and consultant who is considered the father of creativity training.

Polaroid vice-chairman Buckler contends that senior managers who stand aloof from creativity training are making a mistake. "We have a responsibility to create a climate in which real creativity is welcome," says Buckler, who says that he uses the techniques in his own work. "You can't delegate that. We want to make a strong statement in the company that we value creativity and that it's a priority."

But merely providing creativity training is not enough. True innovation requires that the organization be receptive to new ideas. "Corporations that are training researchers to be more creative "are focusing on people as the problem," says Ranganath Nayak, senior vice-president at the Cambridge, Mass., consulting firm Arthur D. Little. "But the problem is not the people," he says.

"There are lots of good ideas out there. The problem is the system for managing research and development."

"If all you're doing is creativity training, you'll be disappointed," adds Gifford Pinchot, a consultant based in Brandford, Conn., who has shifted his focus from creativity training to the innovation process. He recently surveyed 200 client companies that had produced new ideas at his creativity sessions during the last decade and found that "few of these companies had implemented the ideas." The reason, says Pinchot, is that "often there is no one person within the company willing to work to drive the idea through the inevitable corporate barriers." Ideas cannot make their own cases in busy organizations; to succeed, they need champions or sponsors with the passion or the power to push them.

A study of creativity among corporate research scientists in the late 1980s suggests that the work environment itself is a critical factor in stimulating or blocking creativity. Study co-author Teresa Amabile, a psychology professor at Brandeis University, says that the challenge of the work, a sense of ownership in it, autonomy, stimulating co-workers, and management encouragement all seem to nurture creativity—and that scientists, when defining what it takes to be creative, rate these factors as more important than individual traits.

Xerox PARC, for one, eschews creativity training but takes considerable pains to create an environment that encourages researchers to reach for new ideas. Managers expect researchers to grapple with problems that are risky and adventurous and to pursue cross-disciplinary work. Scientists who dwell on status quo problems are asked to leave, says center director Brown. Staff are encouraged to visit universities, other parts of the company, and research institutes to keep up with new trends—and even to work directly with customers.

A few companies have taken dramatic steps to reshape the climate for both invention and innovation. Hoechst Celanese, for example, opened an Office of Innovation to help research employees take ideas and run with them. It is not merely a suggestion box but a vigorous support operation that offers creativity training, helps entrepreneurial researchers focus and refine ideas, ensures that they have the time to work, and provides funding and other resources.

In another twist to foster creativity and innovation, Medtronics, a medical devices company in Minneapolis, invites its elite researchers (generally those who have the most patents) to help top managers set the technical direction of the company. Allstate Business Insurance is seeking to change compensation programs to reward team performance as well as individual achievement. Hewlett-Packard, Texas Instruments, and 3M encourage select groups of employees to spend on-the-job time thinking about new products or ways to improve the business. 3M has committed itself to earning 25 percent of its revenues from products that are less than five years old—a goal that makes creativity a corporate imperative.

Because the kinds of products that companies must deliver today often involve diverse specialties, companies could tailor incentive programs to encourage teams to operate like small entrepreneurial outfits within the larger organization, say innovation experts like Kuczmarski and Pinchot, with team members investing some of their own capital and also receiving a share of any profits.

Even ardent creativity boosters echo the charge that creativity alone isn't enough. Lindsey Collier, an engineer who brought creativity training and the humor room to Kodak, says that while top managers laud creativity training, they do little to push it. Now a consultant, he charges that Kodak's "innovation network," a program aimed at collecting and fostering new ideas from employees and customers, is mired in red tape. Industry watchers and former executives have leveled similar criticism against Du Pont and Exxon.

But creativity champions like Polaroid's Merritt say that if teams are to be the heart of restructured research programs, as the critics suggest, creativity techniques can help. When companies throw together employees from research, marketing, and manufacturing—and sometimes even include customers and suppliers in the mix—pattern-breaking and excursion exercises could help these teams become more cohesive. "Creativity techniques help a group to find a common bond," she says.

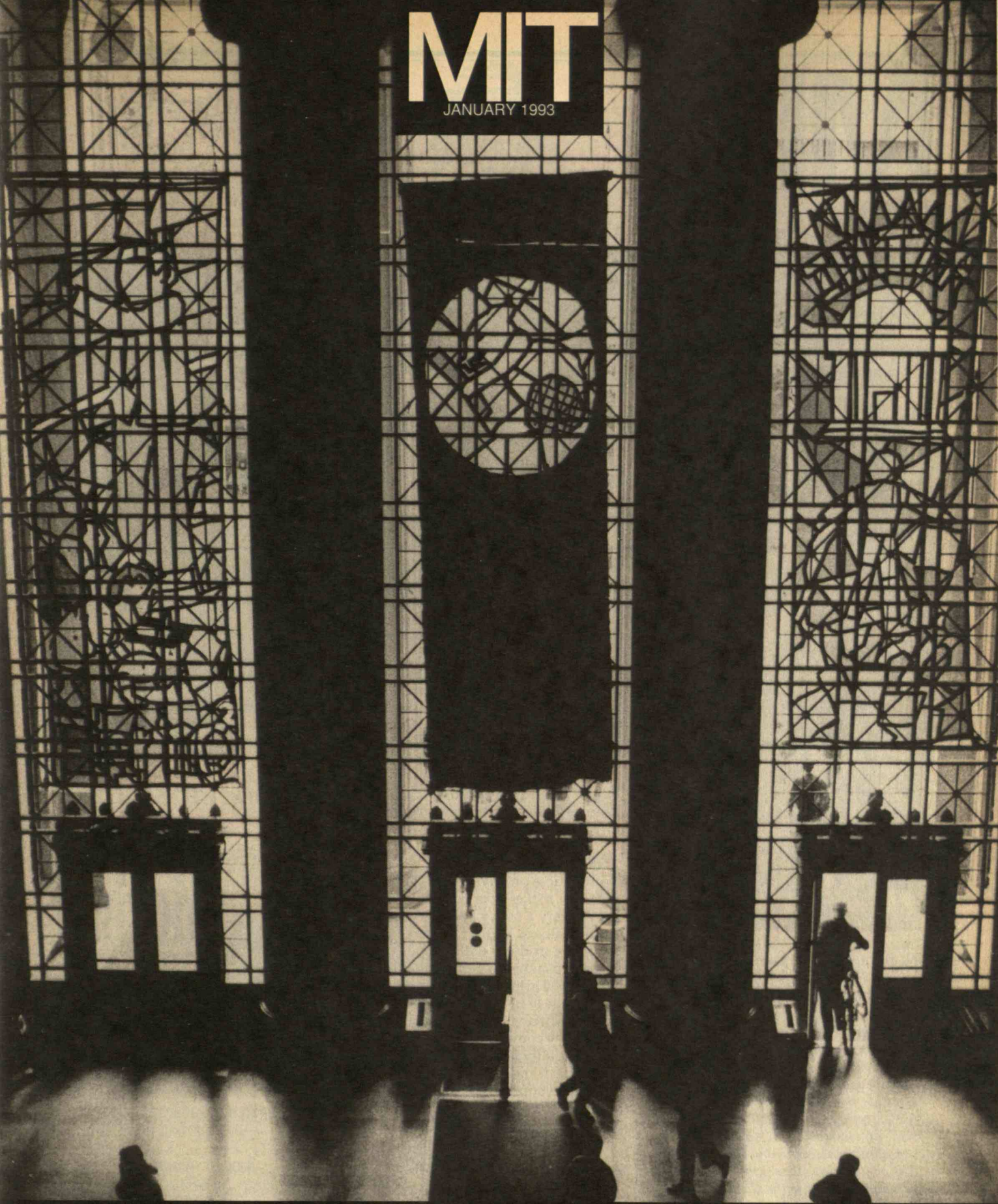
Much corporate interest in creativity still focuses on departments that are already strong on this count, such as R&D and marketing. But it would be a mistake to confine creativity efforts so narrowly; why carry coals to Newcastle? Besides, measures that cut costs or improve quality—which often are suggested by shop-floor workers or customer-service staff—usually can be implemented much more quickly than ideas for new products. "Most of our successes with creativity are in continuous improvement," says Dennis Carter, a resource training manager at a Du Pont fiber-making plant in Buffalo.

In the long run, argues Xerox PARC's Brown, corporations and their employees need to learn how to "reinvent innovation, not reinvent invention." Dramatic changes in markets—like the shift from minicomputers to microcomputers—are occurring more frequently and more rapidly, washing away companies that cannot adapt fast enough. Organizations ought to be thinking—creatively—about how to understand and exploit rapid change.

"If we can understand how to do that," Brown says, "then we may be better positioned to tap the inherent genius of invention in the American spirit."■

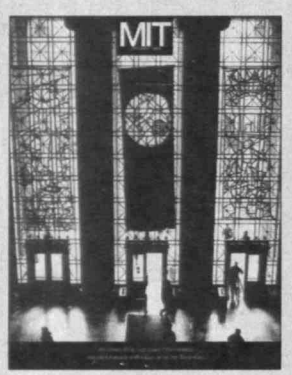
MIT

JANUARY 1993



Halloween Hack 1992: Lobby 7 Transformed into the Cathedral of Our Lady of the All-Night Tool.

MIT
January 1993



Cover:
Having agreed last June to pull it off, more than 60 hackers began planning—and building—just after Rush Week to transform Lobby 7 into a cathedral to technology. To make memorable the last class day before Halloween, they installed altars with gilded computers, pews, organ, stained-glass windows, formulae inscribed on the skylight, an Apple-equipped confessional running ELIZA ("confessional" software), commandments on stone tablets (e.g., "Thou shalt not sleep"), and even a collection plate for the Cathedral Building Fund. True to hacking tradition, they did it all in an hour. Photo by Donna Coveney, MIT News Office.

LETTERS

STOP WHINING, START CHANGING

I found Victor McElheney's article about the President's Council of Advisors on Science and Technology meeting ("A Pall Over University Science," *October, p. MIT 2*) to be very disconcerting.

Certainly a profound distrust for science and scientists has developed in Washington and among the general public. However, anyone with a modicum of common sense should realize that self-serving whining and complaining will not restore the public's confidence, but will rather confirm that the distrust was well founded.

University administrators are complaining that government support for scientific research is inadequate. However, the public perception is that funds that the research universities are now getting from the government are not being used effectively for the purpose for which they were intended. Unless that perception can be changed, it is very unlikely that government support for science will increase.

The only way to regain the public's confidence is to admit that there are real problems and to demonstrate that the public's concerns are being addressed.

ROBERT J. YAES, '63
University of Kentucky Medical Center

Editor's Note: See "Making the Case for a Renewed Alliance," beginning on p. MIT 5, for a report on this subject.

THE MILITARY'S RIGHT

Your article on gays in ROTC (*October, p. MIT 4*), makes a big point of the fact that the military's policy on homosexuality is not the same as MIT's. I am sure that there are many students with various physical handicaps who do very well at MIT and will do well in life. However, in this case we appropriately respect the military's right to be more selective than the school.

The gay community frequently tells us that sexuality is 100 percent determined before birth and can't be changed by environment, counseling, etc. If this is so, why does it take Mr. Bettiker and others (including a well-publicized case at Annapolis) 20 years to figure out that they are gay?

TED HOGG, '47
Aurora, Ill.

SYMBOL LOGIC

I was somewhat dismayed to read the article "Was It a Rat I SaW" by John Travis, '90 (*August/September, p. MIT 6*). My beaver is

still on my finger after 61 years. The shanks have worn smooth, but the proud beaver is still doing his job. We were born in a nicer age and would always give the noble beaver the name that honors him. To us the beaver was a Tech symbol and did not belong to any particular class. Placing it on our finger was a rite whereby we pledged to emulate the beaver and to be hard working, honest engineers. We were destined to be builders.

And now I read that each year small minds at Tech are attempting to change this symbol in their own little ways. One thing any engineer should learn is "If it ain't broke, don't fix it." The beaver is recognized worldwide. Do not belittle it with silly changes.

GEORGE L. HICKEY, '31
Saugerties, N.Y.

Several hundred members of the MIT community gathered for a candlelight ceremony to mourn the murder of Yngve Raustein, '94, by three youths who were from Cambridge Rindge and Latin School.

Murder Stirs Shock, Sorrow, and Intensified Security

Although violent crime is all too frequent in the greater Boston area, the murder of an MIT student only 100 yards from the president's house on Memorial Drive drew intense coverage from regional and even national media. Shocked and deeply saddened, the MIT community has reacted to the September 18 murder of Yngve K. Raustein, '94, by looking both outward and inward.

A number of factors deepened the sense of outrage and fear that such an event would normally engender. Raustein, an extraordinarily able and likable student, was, as President Charles Vest noted, a "visitor in our country" from Norway. At the time of the assault, he was doing something that should have been quite safe—walking along Mem. Drive, opposite the Hayden Library, with a male friend at 9:45 at night. His three alleged assailants, all students or former students at Cambridge Rindge and Latin High School, were reportedly engaged in a brutal street game, and Raustein was a victim chosen entirely at random. Most terrifying of all, the youths showed no regret for their action, and in fact some of their peers were quoted as making callous remarks like "Murders happen all the time."

The tragedy evoked swift responses from the Institute, the City of Cambridge, and Cambridge Rindge and Latin, focusing on the social breakdown that can lead to violence and the activities that may heal it. Within days of the murder, a candlelight vigil was held by MIT students, and CRL students marched from their school to MIT to express their sorrow that their fellow students had carried out such a violent crime. President Vest addressed a letter to the students, faculty, and staff—and later to parents of students—expressing the community's anguish.

Lines of communication were immediately opened between MIT and Raustein's family, and representatives of the Institute flew to Os, Norway, for his funeral. His parents and brother came to Cambridge in October for a moving memorial service in the Bartos Theater, attended by the housemaster and residents of Raustein's dormitory, Baker House, and many others. And an award has been established in his memory—a prize for a student enrolled in Aero & Astro's Unified Engineering subject who exemplifies Raustein's outstanding achievement and his overcoming of personal difficulties. (The young Norwegian earned straight A's in the class, notorious as one of the hardest at MIT, in spite of having transferred to MIT as a sophomore and having to work in a foreign language.)

The tragedy provoked the sudden realization that, in the words of Bill Jackson, '93, opinion editor of *The Tech*, "the rules have changed." The Harvard Bridge is *not*

PHOTO: MICHAEL FRANKLIN/*THE TECH*

The tragedy sent up a red flag: the rules of campus safety have changed.

a safe place, Jackson observed grimly. A lone woman is *not* the only potential target for violence; individual metabolism and workload are *not* the only factors to be considered when scheduling a return from the lab to the dormitory.

Attention almost immediately focused on campus security, accelerating a review process that occurs throughout the year, says MIT Police Chief Anne P. Glavin. She met with parents' groups, students, and staff in the weeks following the murder. Campus security relies on several components, most noticeable being the patrol unit, which comprises the largest segment of the 55-person force. (Other units cover special services, crime prevention, and parking and traffic). The unit's foot patrols—six itineraries—follow designated paths around the periphery of the campus and onto the grounds, backed up by two marked cruisers, with a third car available. Last year, Glavin says, the force also added bicycle patrols—one or two officers two-wheeling around the grounds in patterns dictated by the needs of the day.

An estimated 150 students from Cambridge Rindge and Latin marched from their school to MIT to express their sorrow and concern.

The heaviest patrols, she says, coincide with the high-crime hours, which means that the bulk of the force works from 6 pm to 2 am, in two overlapping shifts that keep 6 to 10 officers on and around the campus. Following the attack on Raustein, who had been walking with his countryman Arne Fredheim, an undergraduate research associate, the force has shifted the focus of these regular patrols. More attention is being paid to the periphery, that vulnerable meeting place of town and gown, according to Glavin.

Since Memorial Drive falls within the purview of the Massachusetts State Police and the Metropolitan District Commission (MDC), and other streets adjacent to the campus are under the jurisdiction of the Cambridge City Police, the MIT force has also stepped up communication with these law-enforcement agencies. The state police, according to Glavin, have agreed to increase patrols of Mem. Drive, and the city police have assigned more plainclothes and uniformed officers to the areas adjoining the campus. Cambridge police have also begun what Deputy Superintendent Harold Murphy calls community policing, which means getting out of their patrol cars to talk and mingle with both MIT and city residents who frequent the area.

Campus Police, other members of the Institute's Committee on Safety, and Senior Vice-President William Dixon, '56, are reviewing a number of preventive measures. Existing features, such as outdoor lighting, the blue-light emergency telephone system, and the Safe Ride evening shuttle, have been highlighted for improvement. The number of trips offered by the increasingly popular shuttle service to MIT residences on both sides of the river, now in its second year, will be doubled, according to Dixon. Currently operating with two 12-passenger minibuses, Safe Ride will be acquiring two more vehicles and hiring six additional drivers in order to cut down on waiting time, make scheduling more predictable, and thus encourage students to use this service.

Additional emergency telephones will also be installed. "We've picked out seven or eight locations that will give us the biggest bang for the buck, relatively close to Memorial Drive," Dixon says. These telephones may be tied in with additional lighting. Since Mem. Drive is not under Institute jurisdiction, MIT is discussing improved illumination with the MDC. Several options are being considered, he says, including letting MIT use an abandoned MDC conduit to run its own sidewalk lights and increasing lights along the MIT property.

No program can work without student involvement, however. While Glavin takes it as a good sign that requests for information have tripled since the murder , MIT is not waiting for students to take the initiative. Both crime-prevention and counseling units are creating opportunities to meet with students, particularly by going into the residences, on and off campus.

Robert M. Randolph, associate dean of students and head of the university counseling services, outlines guidelines for students and staff that emphasize the use of Safe Ride. "Think about where you're going in advance and plan your path," Randolph urges students. "Be aware that this is a high-crime area, and that we are an island in the middle of it."

Student response has been substantial. "A lot of people on campus have become more safety conscious," says Shally Banfal '93, president of the Undergraduate Association. She cites Project Awareness, a joint committee of students and police, which sponsored "Safety Days" to teach basic street smarts. "It's easy to think that this campus is a very safe place, and that as long as you stay on campus, nothing can go wrong," she says, but these days, students have begun to protect themselves, consciously noting emergency phone locations and often carrying whistles or noisemakers to deter potential assailants or summon help. And everyone seems to have memorized the phone number for Campus Police.

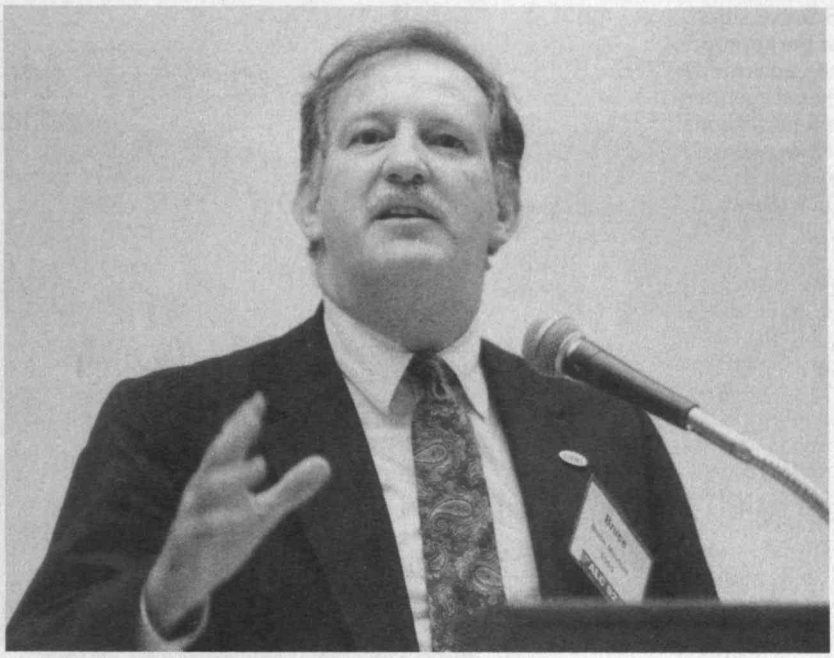
"If we all learn this lesson," Bill Jackson wrote in *The Tech*, "that is the only possible good that can come from [this] tragedy."

—CLEA SIMON *(The author is a freelance writer and editor whose work has appeared in university and newsstand publications from* Harvard Magazine *to* Rolling Stone.)□

PHOTO: DOUGLAS D. KELLER/*THE TECH*

Making the Case for a Renewed Alliance

There are few things as painful and perplexing as a romance gone sour. When that romance is the 50-year partnership of research universities like MIT and a once-doting U.S. government, the breakdown of the relationship has particularly wrenching implications. Speakers from MIT Chairman Paul Gray, '54, to former congressman Bruce Morrison, '65, used the metaphor of a partnership-on-the-rocks to describe the complex mix of concerns that have helped isolate the Institute—and other U.S. research universities—from a broad public constituency.



Assembled on campus for the Alumni/ae Leadership Conference (ALC) in September, more than 400 active volunteers had little time to bask in the pleasures of recent achievements, most notably having completed an unprecedented $710-million campaign. Instead, they were challenged to help regenerate wide support for MIT's claims on public monies, public priorities, and public trust.

The problem is that although MIT is in the news, much of the news is not good: charges of unethical research behavior in the celebrated case involving David Baltimore, '61; the congressional Subcommittee on Oversight and investigation, headed by Rep. John Dingell (D-Mich.), grilling then-President Paul Gray about research funding by Japanese corporations; highly publicized reports of inappropriate billing for the indirect costs of research at institutions like MIT and Stanford; and the current antitrust case over financial aid practices.

Few outsiders have rushed to the Institute's defense. "The word I hear more than any other is arrogance," said President Charles Vest during one of the ALC's question-and-answer sessions. The "ivory towers" of the nation's most productive research universities—the 100 or so institutions that conduct organized, externally sponsored research in addition to granting advanced degrees—are no longer perceived as a treasure to be protected but as a luxury many citizens feel the country can ill afford. Thus, speakers at the meeting from Vest on down pointed out that alumni/ae are among the best qualified people to make the case for MIT—to their professional associates, their communities, and their friends.

It's time for MIT grads to involve themselves in "the grubby realities of public policy."

—Bruce Morrison, '65

Looking back at the history of research universities, Gray quoted from a letter that Franklin D. Roosevelt wrote to Vannevar Bush as World War II wound down. FDR argued that "the information, the techniques, and the research experience developed by the Office of Scientific Reseach and Development," which Bush directed during wartime, and the thousands of scientists in universities and private industry "should be used in the days of peace ahead for the improvement of the national health, the creation of new enterprises bringing new jobs, and the betterment of national standards of living." In a post-Cold War era—and with the inauguration of a new administration—few would argue that those features of "the days of peace ahead" are not worth having. Yet there is no public consensus that research scientists and the institutions that shelter them will necessarily make a difference in reaching those goals.

During the last 50 years "we behaved as if [research funding] were a God-given right," chided Bruce Morrison, who represented Connecticut's third district in Congress from 1983 to 1991. Morrison, who earned a law degree following degrees in chemistry, pointed out that the heady years of generous government support to research universities occurred at a time when Americans still believed they had "resources to burn." Funding, he argued, was granted not because of "careful thought and planning"—priority setting—but because there was a belief that everything could be funded.

Now, in the 1990s, Morrison said, because "this is not the America where everybody can have everything," MIT alumni/ae must move "to the grubby realities of public policy"—to simultaneously inform decision makers and maintain MIT's leadership in research. If the people intimately involved do not help choose priorities, he noted, those with less grounding *will*. Such activism by scientists and engineers must not be condescending and disdainful, Morrison insists, "but respectful of the democratic institutions of which we are all a part."

Summarizing the key issues at the ALC, MIT Alumni/ae Association President Robert A. Muh, '59, suggested that the volunteer leaders consider these critical questions. "Who decides what will and will not be funded? What are the criteria and how are these choices made? Why is research so expensive? What is the proper role of foreign companies and governments in collab-

PHOTOS: L. BARRY HETHERINGTON

orating in, providing funds for, and using the results of research at U.S. universities?" Muh wondered aloud about the appropriate roles, standards, and protections for the participants in research—federal agencies, congressional watchdogs, and professional societies, as well as universities and individual scientists. And he posed questions about the costs and benefits of undergraduate education and who should bear those burdens.

These questions cannot be reduced to abstract arguments. Today, policies and philosophies are expressed in dollars—where money is being allocated, spent, and withheld. Provost Mark Wrighton pointed to one example: MIT's new biology building is a $50-million capital investment in the future of fundamental scientific research and teaching, and in the new industries expected to spring from advances in the life sciences. Yet it is being built without any federal funding whatsoever, a dramatic change from the past, Wrighton noted.

In a provocative discussion, Morrison and several MIT administrators said that much scientific and technological funding from government is not competitively awarded through agencies such as the National Science Foundation, but is earmarked for line items in congressional authorizations. As Morrison pointed out, a project such as the $8-billion superconducting supercollider was viewed in Congress primarily as a public-works project that would create jobs—a driver to local economies—rather than as a commitment to physics research.

John Crowley, who directs MIT's Washington office, warned that it is essential not to disperse the concentrated resources that give the elite institutions their individual vitality. But it is equally important, Crowley said, to create coalitions among universities and their supporters to argue for reinvestment in scientific priorities that serve the entire community—for example, to join forces as R&D resources are shifted from military to civilian activities.

Vest noted that his own schedule now includes one day each week in Washington, where he will try to follow in Vannevar Bush's footsteps, making the case for a renewed alliance between the research universities and government. "We need to communicate our message that MIT does not play a strictly regional role," he said. "The excellence of research institutions affects the entire country."—*Debra Cash*□

Honoring the

The Alumni/ae Association's highest award, the Bronze Beaver, was awarded to (from left): Paul Rudovsky, John Hrones, Gary Schweikhardt, and Edgar Eaton.

At the annual awards luncheon during the Alumni/ae Leadership Conference in September, Association of Alumni and Alumnae of MIT President Robert A. Muh, '59, presented awards for distinguished service. In his introductory remarks, Muh noted that the activities honored through the awards—recruiting students, fundraising, and organizing activities that engage and enrich the alumni/ae community—are critical in maintaining the excellence of MIT.

The Bronze Beaver for distinguished service, the highest award given by the Association, was bestowed on four alumni this year. They join a select group of fewer than 200 graduates who have been so honored:

■ **Edgar P. Eaton, Jr.**, '44, served as president of his class and a vice-chairman of the Leadership Campaign (1977–80), was a member of the Alumni/ae Fund Board, and worked vigorously for his 40th reunion gift. An active *Campaign for the future* volunteer, Eaton also served as a member of several Alumni/ae Fund Visit Programs from his home base in northern New Jersey. Eaton has been described as "a consummate volunteer."

■ **John A. Hrones**, '34, SM '36, ScD '42, has been an MIT activist for 60 years, beginning in his undergraduate days and continuing during his tenure as a professor in the Department of Mechanical Engineering. Since his retirement, Hrones has been involved as member and president of the MIT Club of Southwest Florida, reunion gift solicitor for the Alumni/ae Fund, and member of a Corporation Visiting Committee. As both vice-president and president of his class, he has worked continuously to keep his classmates connected to both MIT and each other.

■ The diverse and extraordinary volunteer service of **Paul Rudovsky**, '66, began when he became class secretary at his 10th reunion. In quick succession, he became a director of the New York Alumni/ae Center and chair of the Alumni/ae Officer's

Movers and Shakers

The Alumni/ae Leadership Conference in September was the first major event at which 1992–93 Association President Robert Muh presided.

Lobdell Awards for distinguished service went to (from left) John Chisholm, Gregory Coutts, Gordon Lister, Robert Wasson, and Harold Seykota. Robert Blumberg was unable to receive his award in person.

Conference. As 25th reunion gift chair for his class, he achieved record participation for a 25th reunion gift. While remaining active at the New York Center, he also serves on the Association Board of Directors as a vice-president and chair of the Audit and Budget Committee. He worked on many committees for the *Campaign for the future*, and led a project to establish a named scholarship fund.

■ **R. Gary Schweikhardt**, SM '73, has been an active alumnus and leader since his graduation from the Sloan School of Management. Serving the Educational Council for nearly a decade, he is also a leader in the MIT Club of Puget Sound and the MIT Enterprise Forum—most recently as the inaugural chair of the forum's National Advisory Committee. Schweikhardt chaired an Alumni/ae Fund Visit Program during the *Campaign for the future*, and he has served as a director and vice-president of the Association's Board of Directors. He also played a leading role in initiating the series of touring presentations on MIT's "Made in America" report.

Six alumni were honored with the Harold E. Lobdell '17 Distinguished Service Award, given in recognition of alumni/ae relations service of special depth over a sustained period:

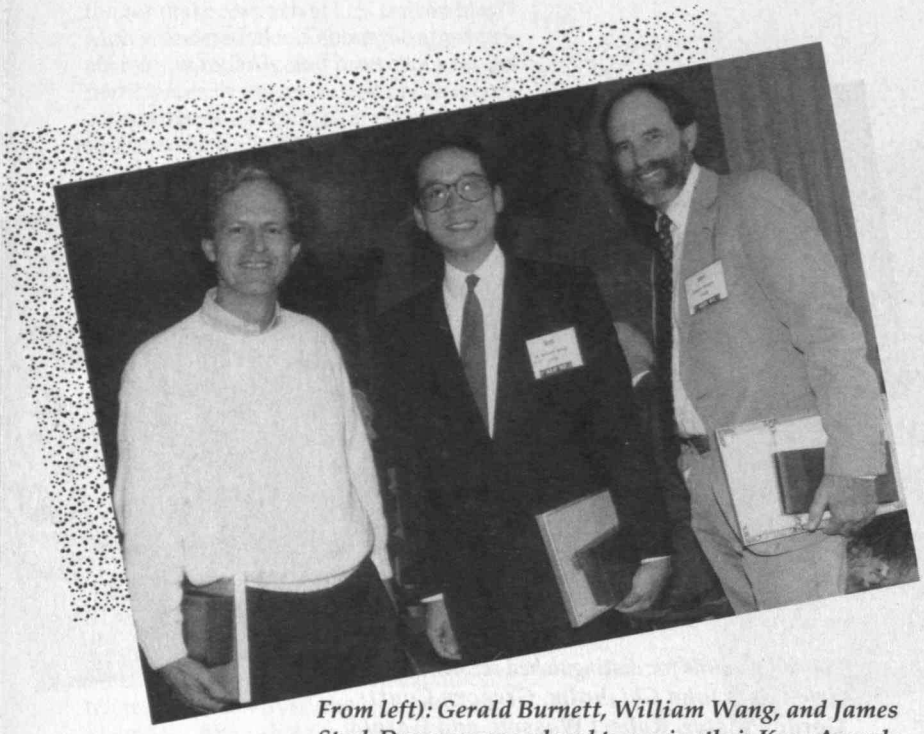
■ **Robert L. Blumberg**, '64, SM '65, has devoted significant time, insight, and direction to MIT. He served with distinction as a regional leader for the *Campaign for the future*, a member of the Educational Council, and an effective volunteer for Class of 1964, the MIT Club of San Diego, the Enterprise Forum, and the Alumni/ae Fund Visit Program.

■ **John Dana Chisholm**, '75, SM '76, has distinguished himself as a creative, thoughtful, and energetic volunteer for the MIT Club of Northern California, the Educational Council, the National Selection Committee, the Alumni/ae Fund Board, and the Silicon Valley Alumni/ae Fund Visit Program (the last-named program was awarded a Presidential Citation.) No one attending the conference was more pleased with Chisholm's award than his mother, Elda Chisholm, '49, herself a Lobdell holder since 1987.

■ **Gregory C. Coutts**, '77, received the Lobdell Award for his vision and creativity as a leader of the MIT Club of Ontario, for his service to the Educational Council, and his dedication to the MIT/York University Enterprise Forum.

■ **Gordon K. Lister**, '30, has vigorously carried out the role of class secretary to the Class of 1930 for some 32 years, demonstrating sustained and thoughtful loyalty and offering invaluable assistance toward enhancing the contributions of all class secretaries.

■ For more than 52 years, **Harold K. Seykota**, '39, has travelled through 75 countries as well as the entire United States to maintain contact with the Class of 1939, visiting in the homes of nearly 60 percent of his class. He has been a great



From left): Gerald Burnett, William Wang, and James Stark Draper were on hand to receive their Kane Awards for fund-raising achievement. Robert Metcalfe and Larry Birenbaum were unable to attend the awards luncheon.

Receiving Morgan Awards for contributions to the Educational Council were (from left) Richard Cole, Ingram Lee, and David Mitchell. Honored but unable to be present were Walter Conrad and Burkhart Kleinhofer.

resource for a number of MIT clubs and for the Association.

■ **A. Robert Wasson,** SM '78, MTE '77, PhD '78, has demonstrated his deep commitment to MIT through continual service as an energetic member of several alumni/ae clubs, through his efforts as a fund-raiser and educational counselor, and as a leader of the Enterprise Forum of Pittsburgh.

The Henry B. Kane '24 Award, given in recognition of exceptional service and accomplishments in fund-raising for the Institute and/or the Association, was awarded to five alumni in 1992:

■ **S. William Wang**, '75, chaired the Westchester/Fairfield (N.Y.) Alumni/ae Fund Visit Program in the fall of 1991, setting and reaching high personal goals. He serves as class agent for the Class of 1975 and as membership chair for the New York Alumni/ae Center.

■ As chair of the Silicon Valley Campaign Committee, **Gerald J. Burnett**, '64, SM '65, was an outstanding leader of the *Campaign for the future*. On his own initative, Burnett hosted a major campaign event in his home in the Bay area to honor MIT grads who founded companies. He also helped revitalize the Class of 1964's Reunion Gift Committee and move it toward its goal.

■ **James Stark Draper**, '62, SM '64, PhD '71, has made a passion of funding scholarships that both honor deceased alumni and help support young women qualified and eager to study science and engineering. He singlehandedly led the effort to raise several undergraduate scholarships in the name of his fraternity mentor. Draper's energy and enthusiasm have done much to strengthen the scholarship resources available to women and to publicize the availability of careers for women in traditional MIT disciplines.

■ **Robert M. Metcalfe,** '68, was honored for exceptional work as co-chair of the Silicon Valley Campaign Committee for three years. A highly visible promoter of MIT in northern California, Metcalfe believed strongly in the *Campaign for the future* and made a large commitment of time and energy to the fund-raising effort.

■ Another outstanding fund-raiser from the Silicon Valley Campaign Committee is **Larry Birenbaum**, '69, who took over as committee co-chair in June 1991. He had previously served for several years as an Alumni/ae Fund Visit Program solicitor. Birenbaum's continuing commitment and enthusiasm for MIT make his presence in northern California invaluable.

The George B. Morgan '20 Awards were created to recognize sustained excellence in all aspects of Educational Council activity. Vincent James, '78, director of the Educational Council, presented the 1992 awards to five alumni:

■ **Richard E. Cole**, SM '52, has served the Educational Council for 22 years, including seven years as regional chair, 1980–86. At

Representatives of the four programs to be honored with Presidential Citations were on hand to receive the awards. From left: David Chen, '75, for Chinese Alumni/ae of MIT (CAMIT); George Schwartz, Floyd Lyon, and Jack Sheetz, for the Class of '42; William Maini, '51, and George Clifford, '48, for the Technology Day Committees; Molly Krakauer (Mrs. Charles, '54) for the Committees of the Emma Rogers Society; and Kenan Sahin, '63, also for the Technology Day Committees.

one time or another, he has filled every role the EC has to offer, from visiting high schools to hosting Admissions Office staff.

■ **Walter P. Conrad, Jr.**, '56, has been an active member of the Educational Council since 1966 and has served as regional chair since 1969. Conscientious and thoughtful when handling Council responsibilities, Conrad maintains excellent rapport with the schools that he serves.

■ **Burkhart A. Kleinhofer**, '39, has been an active and loyal member of the Educational Council since 1967 and has been vice-chair since 1982. He has done a stellar job and has ensured that all the high schools in his region have MIT representation.

■ **Ingram Lee**, '49, joined the Educational Council in 1965 and has been regional chair for almost four years. He is known for effort beyond the call of duty, such as hosting admitted students at his home and attending many college fairs in his area.

■ **David H. Mitchell**, '56, SM '57, joined the Educational Council in 1956 and has been vice-chair since 1971. As vice-chair, Mr. Mitchell is extremely well organized, which is critical to functioning in his region, Southwest Los Angeles. His counselors are kept well-informed, and Mitchell ensures that all high schools have proper MIT representation.

Since 1955, Presidential Citations have been awarded to groups or programs for distinguished service to MIT, the Association, and alumni/ae of MIT. This year, four very diverse groups were awarded Presidential Citations:

■ **The MIT Committees of the Emma Rogers Society**, "for establishing the Emma Rogers Society and creating the most sensitive and supportive of programs on behalf of MIT's widows." In 1990, MIT made a commitment to explore the ways in which widows of alumni and faculty might wish to continue their association with the MIT community and how MIT might facilitate strong ties. Through a series of creative discussions over many months, 16 volunteers devised the diverse programs that characterize the Emma Rogers Society today. Those programs include an outreach packet of helpful information that is sent to the newly widowed, a newsletter, a directory of members, seminars on personal finance and other topics, and occasional all-day events through which members may return to campus.

■ **Chinese Alumni/ae of MIT (CAMIT)**, "for excellence and quality of programming efforts for Chinese alumni and alumnae." Each year, in addition to their New Year's Banquet in New York City—which attracts over 100 guests—CAMIT holds five or six other well-planned events. Last year, they also produced a quarterly newsletter and a worldwide directory of Chinese alumni/ae.

■ **The Class of 1942**, "for their 50th Reunion, Reunion Gift, and Reunion Book

efforts." The volunteers of this class did an outstanding job in combining all aspects of their reunion and reunion giving, resulting in new records for both attendance and a 50th reunion gift. They also set a new standard with their 50th Reunion Book, generating early enthusiasm for the reunion. Class officers, committee members, and rank-and-file members of the class worked over the two years prior to the reunion, giving generously of time, expertise, and financial support.

■ **The Technology Day Committees of 1990, 1991, and 1992**, "for dramatically elevating the quality of the Technology Day programming." These three committees articulated a rationale for the Technology Day programs and wrote a comprehensive mission statement. They chose broad topics that involved as many departments as possible, thereby inspiring enthusiastic participation by faculty and alumni/ae. □

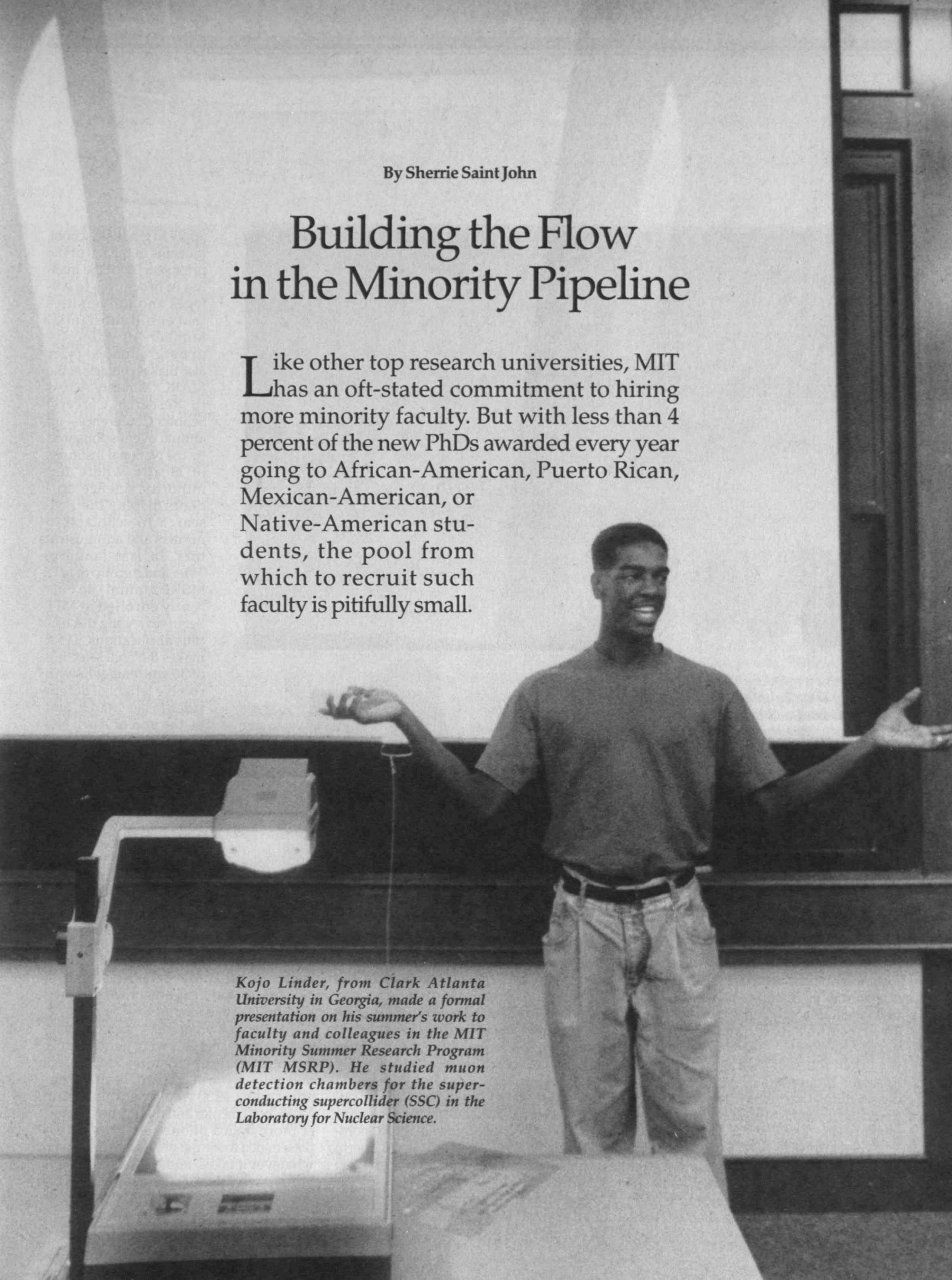
—ROBERT DIMMICK *(The author is the administrative assistant to the executive vice-president of the Association of Alumni and Alumnae of MIT.)*

Corporation Chair Paul Gray was quite taken with the gray jackets ordered for their 25th Reunion by the Class of 1967, the first 25-year class to march at Commencement. In a surprise presentation at the ALC, Gray received his own gray jacket from William Hecht, '61, Alumni/ae Association executive vice-president, as Robert Muh looks on.

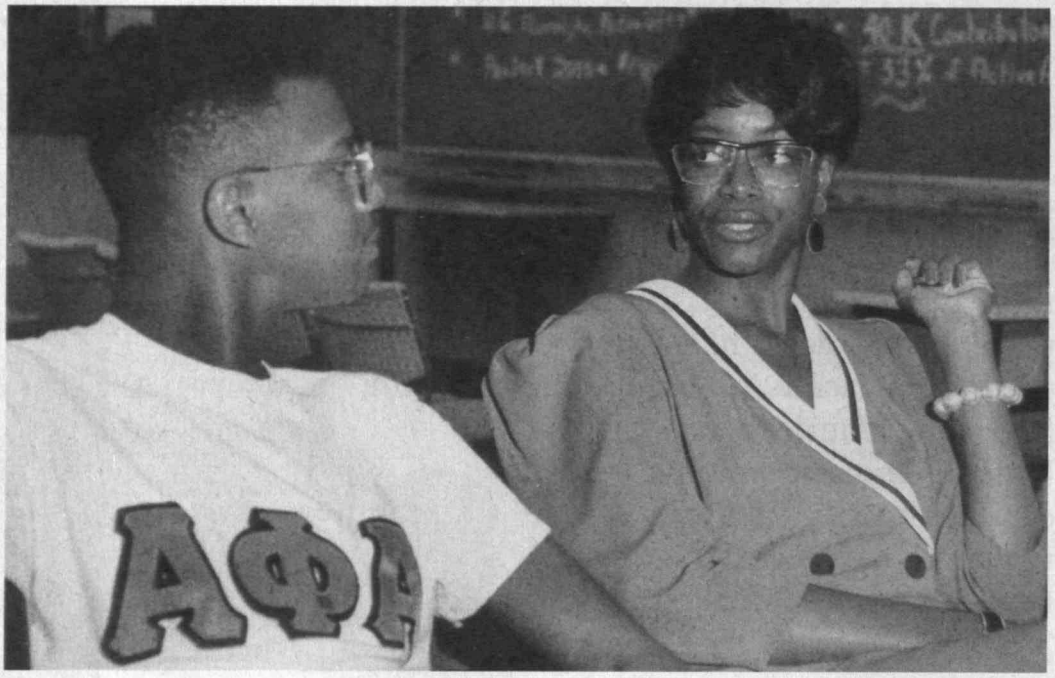
By Sherrie Saint John

Building the Flow in the Minority Pipeline

Like other top research universities, MIT has an oft-stated commitment to hiring more minority faculty. But with less than 4 percent of the new PhDs awarded every year going to African-American, Puerto Rican, Mexican-American, or Native-American students, the pool from which to recruit such faculty is pitifully small.



Kojo Linder, from Clark Atlanta University in Georgia, made a formal presentation on his summer's work to faculty and colleagues in the MIT Minority Summer Research Program (MIT MSRP). He studied muon detection chambers for the superconducting supercollider (SSC) in the Laboratory for Nuclear Science.



For Margaret Tyler, associate dean of the graduate school and head of MIT MSRP (shown above with Melvin Williams, a senior from Talladega College in Alabama) the wind-up luncheon is a chance to reflect on the program's potential impact on the careers of student—and faculty—participants. Rosa Arriaga (right) conducted research on infants' concepts of object identity in the brain and cognitive science laboratory of Professor Susan Carey.

MIT is not sitting on its hands, waiting for an upturn in the supply. For the past six summers, the Institute has recruited the top science and engineering undergraduates from predominantly minority colleges and given them an intense introduction to the world of academic research. The program is called the MIT Minority Summer Research Program (MIT MSRP), and it is designed to attract minority students into graduate programs and ultimately into academic posts.

"Convention has it that motivated minority students with expertise in science often jettison directly into medical school," says program head Margaret Daniels Tyler, assistant dean of the MIT Graduate School. "This program is hoping to encourage some of them to see the value of scientific research in an academic setting." And so far, it is benefiting MIT even in the short term—first by motivating 10 of the 86 MIT MSRP alumni/ae to enroll here for master's and doctoral degrees, and second by stimulating new scholarly collaborations for MIT faculty.

Last summer, Tyler, herself a Harvard-educated African American, admitted, assigned, counseled, and monitored the 20 African Americans, 6 Puerto Ricans, and 4 Mexican Americans enrolled in MIT MSRP.

The MIT MSRP recruitment process is a good dry run for students who will later apply to graduate school. It begins in the fall of the prior year, with the mailing of brochures to colleges and universities that enroll substantial numbers of minority undergraduates. Tyler also makes contacts at the MARC (Minority Access to Research Careers) Scholar Conference—an annual event sponsored by the National Institutes of Health where top minority science students display their research to scholarship funders and administrators. In late January, Tyler and a group of MIT MSRP alumni/ae currently enrolled at MIT begin reviewing the 100-plus applications. Tyler makes the final selection of 30 students who will receive letters of acceptance in late March, and by the end of April she expects to have 19 or 20 acceptances in hand.

In spring 1992, it didn't quite work that way. "I sent out 30 letters of admission and promptly received 30 acceptances," says Tyler. "I was both pleased and surprised!" The support Tyler has received from the MIT faculty has been overwhelming: 48 professors came forward in summer 1992, some hoping to enlist more than one student. There was a rich array of projects to match against the students' backgrounds and interests.

The 10-week program is "support intensive," both financially and in human terms. It covers round-trip airfare to Cambridge in mid-June, room and board, health insurance, and a $250 weekly stipend. And Tyler, both mentor and mother hen, is never more than a phone call away. She is determined to see the program work, doing whatever it takes, and her success rate is impressive. Of the 86 students who have gone through the program to date, 85 have continued on to post-graduate work.

PHOTOS: L. BARRY HETHERINGTON

In the program's early days, it was almost entirely subsidized by MIT, but now in addition to the support in the form of faculty time, materials, and lab space, it is also supported by grants from the Hearst Foundation, the National Science Foundation, and NIH, among others. In addition to more long-term funding, goals for the program include more interaction between MIT faculty and the institutions that send their students to MIT MSRP. "It is great that students are provided with the opportunity to attend MIT, but we aren't bridging the necessary gaps when we fail to reach professors at the students' home institutions," says Frank Perkins, '55, dean of the Graduate School. "We need to open up lines of communication on a higher level."

Tyler agrees. "What we are doing here is not only creating opportunities for minority students. We are also creating visibility for predominantly minority institutions," she says. "Professors at these colleges typically shoulder such heavy teaching loads they are unable to fully participate in the national research arena." They often aren't in the loop of conferences and papers, thereby missing opportunities to meet and interact with their colleagues at MIT and other large research universities. But experience has shown that contacts with frontline researchers through programs like MIT MSRP can assist these academics as they provide guidance to their students.

Above left to right: MIT MSRP participants Pamela Clayton, Felipe Luyanda, and Carolyn Cohran. Both women are students at Tougaloo College in Mississippi. Clayton spent the summer modeling the impact on the nitrogen balance in Massachusetts Bay waters of moving a sewage outfall pipe from Boston Harbor into the bay. Cohran focused on improving a testing procedure for studying chemically induced mutations of DNA. And Luyanda, a student at the University of Puerto Rico, worked in the Laboratory for Nuclear Science on aspects of muon detection in the SSC. Adrienne Jones (left), a senior from Winston-Salem State University in North Carolina, brings her audience up to speed on her summer investigation of an aspect of the bacterium **e. coli**'s *response to potential mutagens.*

For example , William Thilly, '67, professor of toxicology at MIT, has made trips to a few colleges in the South (including colleges in Atlanta, Jackson, Miss., and Puerto Rico), where he spoke with students and professors, exchanged papers, and began establishing working relationships with both short- and long-term benefits. He recruited a current PhD candidate to the MIT Division in Toxicology as well as two of the 1992 summer scholars from Tougaloo College in Mississippi. Tyler lauds the toxicology program as a model for other departments at MIT: it currently counts four former MIT MSRP scholars among its graduate students.

Opportunities To Speak—and To Listen

True to its MIT base, MIT MSRP gets down to business quickly and never slackens the pace. Thus students must give mini-presentations to the other MIT MSRP participants within their first week. "It's good for them to understand our expectations immediately, so they won't be surprised later on when they have to give their real presentation," Tyler remarks. That "real presentation" is the climax of the summer for each student: a 20-minute summary in a plush conference room in Building 1, in front of a daunting audience of interested MIT faculty, graduate students, and administrators. This year, students were also required to hand in an abstract and a paper detailing their experience.

On Wednesday evenings during the program, the students do the listening, as local scientists and engineers of color talk about their careers. Rosa Arriaga, a Mexican-American senior at San Diego State University, had a typical reaction. "I had never met anyone with a PhD until I went to college," she said, "and it wasn't until

"If we all started out equally, there would be no need for such programs. But we don't start that way."

this program that I met and was able to talk to so many minority researchers!" Arriaga says that she had a rewarding summer working in the lab of Susan Carey (professor of brain and cognitive science), but it was the Wednesday seminars that enabled her and the other students to imagine themselves someday heading their own research programs—not merely serving as staff for someone else.

The Wednesday seminars also attract MIT MSRP veterans like Squire Booker, PhD '92, who are eager to share their experience with the new recruits. Booker has a bachelor's degree from Austin College in Texas, and he was planning to go to medical school when a friend recommended he try out the start-up MIT MSRP. "It was the best thing I ever did, in terms of getting into graduate school," says Booker. "Otherwise, I wouldn't have gone into a research laboratory and I wouldn't have attended MIT." For several years, Booker and his roommate, Delton Cox, another MIT MSRP veteran, were the only African-American graduate students in the Department of Chemistry. After receiving the degree in December, Booker is spending a year at the University of Paris as a postdoctoral fellow in enzymology.

Renee Laidlaw, an African-American MIT MSRP participant from City University of New York's Medgar Evers College, wants to follow in Booker's footsteps and do graduate work at MIT. She spent the past summer working on nuclear magnetic resonance with Bruce Rosen, PhD'84, a research affiliate in nuclear engineering. Laidlaw is interested in biology and computer science, but her undergraduate school only had facilities for studying cell biology. "[My work] this summer allowed me to see the two disciplines working together," she says. "Now I see my computer skills contributing to the study of cell structure instead of competing with it."

Another successful MIT MSRP student is Kojo Linder, an African-American junior from Clark Atlanta University, who spent last summer working under Louis Osborne, PhD '50, at the Laboratory for Nuclear Science. Linder collaborated with a group of researchers in Osborne's lab to write several papers on neutron detection and the cathode materials used in detectors for the superconducting supercollider. Linder then presented one of the papers in October at a conference organized by MIT and Clark Atlanta on research experiences and graduate school opportunities for minority students. The conference, inspired by a suggestion from MIT Provost Mark Wrighton, stimulated the flow of information among university professionals, and it also gave Linder an opportunity to win $500 and the accolades of his peers for presenting the second-place paper in physics.

In an era when the value of affirmative action programs is being debated even within the minority community, this summer's batch of students all support special efforts to give minority students a leg up. "If we all started out equally," says Rosa Arriaga, "there would be no need for such programs. But we don't start that way. I'm not asking for a break. I'm asking for an opportunity."

The opportunity has already begun to pay off for her. At San Diego State, she had been limited to reading textbooks about infant cognition, but at MIT, she studied infants. "The books I had been reading had not taken into account the body of research of which I am now a part," she says. "It is incredibly exciting to see this with my own eyes!" she says. Now, she and her advisor in California are planning to set up their own infant lab. MIT's Susan Carey, who was impressed with Arriaga's enthusiasm, says that the young scholar has a real prospect of publishing her research after only one more summer at MIT.□

CLASS NOTES

16

I'm grateful to Robert B. MacMullin, '19, for this very welcome note that I received in September: "**Chester N. Richardson**, is now being cared for in Mt. St. Mary's Nursing Home, Sixth St., Niagara Falls, N.Y. 14301. He is now 97 years old and had the pleasure of visits from two of his children from California, as well as his youngest, Jane Richardson, of Youngstown, N.Y. Chet speaks with difficulty but still enjoys a good joke." Bob MacMullin refers to himself as an "erstwhile colleague and partner" of Chet. Thanks very much for this information, Bob. Chet came back for our reunion at the Endicott House and on another occasion to a Technology Day celebration, both in the early 80s. I thoroughly enjoyed meeting him and Jane and sharing some wonderful moments with them. I also had the pleasure of meeting his other daughter when she, Jane, and Chet attended Technology Day a few years later. My best wishes go to each of them.

I regret to report the passing of classmate **James M. Ralston** on June 13, 1992. He had resided in the Trenton, N.J., area since 1926, retired as chief engineer with the New Jersey Manufacturer's Association, and in World War I served as an artillery officer. May he rest in peace.

May I also thank Herb Larner, '18, who recently sent me an interesting article on General **Jimmy Doolittle**. In the article it notes that Doolittle enlisted in the Army in 1917 and after World War I, the army "sent him to MIT to study aeronautical engineering. By 1925 he was Dr. Doolittle, with an ScD in aeronautical science, one of the first in the United States." Herb accompanied the article with this note: "Jimmy Doolittle was a friend and classmate of my brother, **Harold Larner**, Course XIII." My sincere thanks, Herb. Keep writing to **Bob O'Brien**, acting class secretary, 25 Keith Rd., Pocasset, MA 02559

18

Correction: The editor apologizes for a typo in the October 1992 issue. Your secretary expressed thanks to Buzz Burroughs, '20, for news about the *late* **Marvin Pierce**

From his son, Paul Jr., we sadly learn of the recent passing of **Paul McGreenery**, retired general manager of the Carter Rice Paper Co. in Boston. He lived in Needham, Mass., for the past nine years and had lived in Hanover for 30 years before that. During World War I, he served as a naval officer aboard the U.S.S. *Pasadena*. In 1922, he was chess champion of New Hampshire. Paul leaves his wife, Agnes, a daughter, two sons, nine grandchildren, 15 great-grandchildren, and one great-great-grandson. On behalf of the class, we express sympathy to his family.—**Max Seltzer**, secretary, 865 Central Ave., Needham, MA 02192

19

Our earlier class reunions were stag and were held at a local yacht club or golf course. They were well attended, but many favored inviting our wives to attend. The matter was reviewed and decided favorably, which worked out well for subsequent reunions. Most were held at the Institute on Technology Day. We decided to hold a one-day event with all the other classes in June 1989, and 12 attended. They were Mr. and Mrs. **Douglas Burckett**, Mr. and Mrs. **Wilfred Langille**, Mr. and Mrs. **Donald Way**, Mr. and Mrs. **Allan McIntosh**, **George Michelson**, and guests. We called our reunion the 70th, and we think we were the first class to put it in place.

The Emma Rogers Society, was established at MIT in 1990 for widows of alumni so that they can be a continuing part of the Institute in their own right. Our success in having our wives share our reunions with us prompts us to support the Emma Rogers Society.

Now, old fellows, take care of yourselves so some of us may attend a 75th reunion.—**W.O. Langille**, secretary, P.O. Box 144, Gladstone, NJ 07934, (908) 234-0690

20

Please send news for this column to: **Harold Bugbee**, secretary, 313 Country Club Heights, Woburn, MA 01801

21

The only bit of news I have this month is of the death of **Oliver F. Coolidge** of Coolidge Farm Rd., Center Sandwich, N.H., January 17, 1992. I met him once in his home when I paid a brief visit while I was on vacation at Squam Lake, N.H.—**Sumner Hayward**, secretary, Wellspring House, E64, Washington Ave. Ext., Albany, NY 12203; **Samuel Lunden**, assistant secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22

At our 70th reunion in the spring of '92, our class was able to stand tall as it presented a $1.3 million reunion gift to the Institute.

It is with regret that your secretary must report the passing of our classmate, **H. Felton Metcalf**, on May 12, 1992, at Goodwin's of Exeter, N.H. Felton had worked as an electrical engineer with RCA for many years. He was an active member of the Newmarket Community Church and the Newmarket Historical Society. A busy, active life was his!—**Martha Munzer**, secretary, 4411 Tradewinds Ave. E., Lauderdale-by-the-Sea, FL 33308

23 70th Reunion

Please send news for this column to: **O.A. Almquist**, secretary, 19 Griswold Rd., Wethersfield, CT 06109

24

We were informed of the passing of two more classmates. **Neil L. Olken** died December 12, 1988, in Newton Centre, Mass. Our sympathy goes out to his daughter, Nancy Feldman. . . . Also **Roland N. Black** from Richmond, Va., passed away August 3, 1992. He was with the New York Telephone Co. for 40 years. He also studied voice at Carnegie Hall and was a semi-professional singer for 60 years. He is survived by his wife, Martha; a daughter and son-in-law, Norene and George Yowell; four granddaughters; and a brother and sister-in-law. He was preceded in death by his first wife, Mary. Condolences to all the family.—co-secretaries: **Katty Hereford**, Box 5297, Carmel, CA 93921; Col. **I. Henry Stern**, 2840 S. Ocean, #514, Palm Beach, FL 33480

25

Archer Nickerson has written after reading of the passing of **Leroy Davis** in the August/September 1992 *Review*. Nickerson and Davis were close friends during their years at the Institute. They took the advanced ROTC course and became members of the Army Air Corps Reserve. When it came time to attend the Army Summer Camp, the two decided to take a leisurely trip to Langley Field, Va., with Nickerson providing transportation on his motorcycle. They stopped for a week at the Davis home in New Jersey and spent a night at a hotel in Washington, D.C., that seemed to cater to elderly ladies. The last night of the trip they put up at the finest hotel in Newport News, Va., after one night at a disreputable railroad hotel.

The passing of two classmates must be reported. . . . **Temple C. Patton** died in Bricktown, N.J., July 1, 1992. Temple worked for many years at the Baker Castor Oil Co. in Bayonne, N.J., where he was manager, Technical Services. He wrote books and technical papers that usually dealt with pigments, and even wrote a romantic novel that incorporated his knowledge of pigments into the plot. He also wrote articles on his hobbies—magic, music, and chess. He is survived by his wife, Doris.

George A. Whinery died July 9, 1992, in Grand Rapids, Mich. A graduate of the University of Michigan, he joined the class of 1925 as a graduate student in mechanical engineering. George was co-owner of Waddel Manufacturing from 1925 until his retirement in 1983. He was a charter member of the Mayflower Congregational Church and former chair of its board of trustees. He was also a member of the Kent Country Club. He is survived by his wife, Katherine Pantlind Whinery, four children, ten grandchildren, and six great-grandchildren.—**F. Leroy (Doc) Foster**, secretary, 434 Old Comers Rd., P.O. Box 331, North Chatham, MA 02650

26

D. Bruce Powers of Mancos, Colo., heeded my request for some more positive news. In May, he and his wife, Doris, visited Munich and a friend there who was a former professor of Russian, currently an official with Radio Liberty. Bruce and Doris also visited quite a bit of Bavaria and had a brief encounter with President Bush's entourage while in Munich. They spent a great deal of time in galleries, museums, stores, and parks. Later, Bruce visited London and some relatives. He's now back in his cabin in Colorado. (Thanks for the update!)

Cyril S. Smith died of cancer last August 25 in Cambridge, Mass. He was an MIT professor emeritus of metallurgy and history of metallurgy. He was famous for his original research in the molecular structure of metals, the shapes of metal grains,

and how the various levels of structures, from microscopic to visible, related to one another. In addition, Smith was an authority on how people, from the beginning of history, had used materials, especially metals, and how their lives and cultures had been affected by them. Smith received 20 patents for his inventions.

After a brief stint with the War Metallurgy Committee, he joined the Manhattan Project in Los Alamos, N.M. His work on nuclear bombs was honored in 1946 with the Presidential Medal of Merit. President Truman named Smith one of the original nine members of the general advisory committee of the Atomic Energy Commission. In 1980 he wrote a book, *From Art to Science*. Smith leaves his wife, Alice, a son, a daughter, and grandchildren. (See obituary on page MIT 38.)

Please send news to: **Donald S. Cunningham**, secretary, Eventide, 215 Adams St., Quincy, MA 02169, (617) 328-1840

27

Last summer I received a letter from **Ted Ordman** in Stamfordville, N.Y., telling of his and his wife's, Valda, ordeals in the aftermath of their auto accident in Florida in December 1989. They were struck head on by a fast-moving car at a crossing of two main highways. His car was totaled and he suffered such severe bruises that they caused clots that settled in the left half of his brain. He underwent brain surgery early in 1990. Valda suffered a fractured left arm and wrist that kept her in a cast for 13 weeks.

Ted studied patent law at George Washington University for one year and two years at Fordham University in New York. He passed the bar exam in New York but was denied a doctor's degree from Fordham. In 1931 he joined the patent law firm of Kenyon & Kenyon as an associate on an experimental basis. This experiment lasted 41 years as Ted prepared and prosecuted hundreds of patent applications for domestic and foreign clients. He argued appeals at the Patent Office on behalf of Kenyon clients and made numerous trips to Europe.

Repeated requests had been made to Fordham Law over the years for his degree, but were denied. In 1990, a new Dean reversed the decision. Ted was awarded a "Doctor Juris" degree during the period of his brain surgery, and feels vindicated now. He hopes to recover and be well enough to attend our 70th Reunion in 1997. He regrets missing our 65th.

Douglas Palmer of Seattle is preparing to write a biography of our classmate, **Sidney Gerber**, who died in a crash while flying his plane in 1965. The biography will cover all aspects of his life. If any of you can give information about his life, please send it to Douglas Palmer, 3746 34th Ave., SW, Seattle, WA 98126; or call (206) 937-6319.

Biderman T. (Ermie) du Pont died on August 26, 1992. A long-time resident of Johnstown, Pa., he became manager of the Plastic Metal Division of National Radiator Co. The company produces iron and other metallic powders in plastic form which are used in the fields of powder metallurgy, electronics, and chemistry. Ermie's first reunion was our 60th in June 1987, although he had hoped to come to our 50th. At his graduation he made two vows to himself: that he would never marry and that he would not attend a reunion. He kept his first, but we are glad in his advancing years, he broke the second vow.—**Joseph C. Burley**, secretary, 1 Harbourside Drive, Delray Beach, FL 33483; **Lawrence B. Grew**, assistant secretary, 21 Yowago Ave., Branford, CT 06405

28 65th Reunion

At the Awards Luncheon portion of the MIT Alumni/ae Leadership Conference on September 19, 1992, at Walker Memorial our loyal and enthusiastic **Florence Jope Smith (Ralph Jope** and **Walter Smith)** and **Frances Donovan (James Donovan)** were awarded Presidential Citations for their participation on the Planning Committee that organized the Emma Rogers Society in 1990. The Emma Rogers Society, named for the wife of the first president of MIT, conducts a program of assistance and companionship to widows of alumni and faculty. This was well-deserved recognition of one of the many valuable contributions Florence and Frances have made to the activities of our class and the Institute over the many since our graduation.

With this issue of the *Review* we are now in the year of our 65th Reunion, a noteworthy accomplishment by those of our class who have participated in and survived a period of great history. Committees of our members and Alumni/ae Association personnel have made plans for a program that should provide for a rewarding gathering of associates in June. We look forward to many responses and your attendance.

There is one death of a classmate to report this month, that of **David Palmer Moore** on May 18, 1992. Our condolences to his wife Margaret, family, and friends.—**Ernest H. Knight**, secretary, Box 98, Raymond, ME 04071; **Hermon S. Swartz**, chairman, 12 Minola Rd., Lexington, MA 02173

29

Helen Dinjian sends the following: "My husband, **Karnig Dinjian**, your secretary, had cataract surgery last June to improve his vision. Because he had had a glaucoma filtering operation a few years ago, it was a difficult surgery to perform. However, the doctors are very confident that his vision will improve, at which time he will be able to again write the class column." The staff of *Technology Review* join his classmates in wishing him a speedy recovery—*ed.* (**Karnig Dinjian**, secretary, P. O. Box 83, Arlington, MA 02174)

30

The year 1992 was secretarially unique in that last year I received news about four classmates and an "almost" classmate from whom I had not heard in more than 30 years. The April 1992 Notes included a reference to **Ernie Tauch** who, although not technically a classmate, is listed as a member of our class and is well known to many of you as the director of the Buffalo Station of the Practice School. First-time reports about **Olin Stephens** and **Harold Brown** appeared in the April and July 1992 issues respectively. First-time items about **Wayne Soverns** and **Margaret Surre Wilbur** follow.

Last summer I received a report from **Wayne Soverns'** daughter, Deanne Ater, bringing the sad news that, like an increasing number of our classmates, he is a victim of Alzheimer's disease. Wayne spent much of his career working as an architect for Skidmore, Owings & Merrill. He worked on such projects as the impressive Arrivals Building at JFK Airport and the Union Carbide building, both in New York City. After his wife, Louise, died in 1982, he moved to Portland, Ore., where he now receives 24-hour care in a facility across the street from his daughter Deanne. He is still able to play pool and tile rummy and enjoys seeing his grandchildren and greatgrands. Wayne's son, Wayne Jr., received an MIT degree in 1965.

Margaret Wilber was a longtime friend of **Louise Hall** and, like Louise, was a 1927 graduate of Wellesley and a recipient of an MIT degree in architecture in 1930. Margaret now lives at Meadow Lakes, a retirement community in Hightstown,N.J., with her husband, Donald, author of a very successful book, *Iran Past and Present*. She lists her career activities as former teacher, archaeologist, and architect. Margaret is now doing volunteer jobs at Meadow Lakes. She called my attention to *Architecture, a Place for Women*, a book to which Louise contributed a chapter entitled "The Fourteen Women of MIT, Class of 1930."

Supplementing the item about **Paul Wang** in last July's issue, which noted his extensive career as an acoustics expert in the aircraft industry, it appears that in 1977 he and Margaret initially elected a pastoral retirement in "a semi-rural area of San Diego with the ambitious idea of planting a variety of fruit and nut trees, colorful flowers, and a productive vegetable garden. But after years of battling the insects, snails, the air and ground assaults from different sources, and especially the furry little gophers which were determined to undermine our efforts by digging a system of tunnels underground, we finally decided to leave the pests and move back to the city and rejoin the work force." He now works as an acoustics expert for the environmental management group of Orange County, Calif., where the most important aspect of his work involves the noise levels generated by vehicular traffic of all types that impact land use requirements in the County. In June 1990 he presented the paper, "On Traffic Noise," at a meeting of the Transportation Board in Honolulu. At present he is working on an amplification of the subject matter of this paper.

Morris Young is still practicing ophthalmology with his son, Charles V. Young, as Associated Ophthalmologists, PC. Charles founded the National Glaucoma Trust, a foundation of which he is medical director, and Morris is a member of the board of directors. Over a period of years, Morris and his wife, Chesley, assembled a large library on memory and mnemonics. The library has been acquired recently by the University of San Marino, Republic of San Marino, as a resource for their Institute of Semiotic and Cognitive Studies, which is under the direction of Umberto Eco. Morris is founder of the Magic Collectors Association and a member of the honorary board of directors of the Houdini Historical Center in Appleton,Wisc.

Carolyn and **Dick Wilson** still enjoy their seven-acre property, located about eight miles east of the center of Rochester, where they have lived for 50 years. Dick reports that "our activities have slowed but we are thankful to still enjoy independent living, our flowers and fruit trees as we battle the deer, the woodchucks, and rabbits." Dick still plays nine holes of golf twice a week in summer and skis in the winter. . . . **Morris Shaffer** reports that "like many others of my age-group, I spend a fair amount of my waking time attending to health matters, but I'm still able to do for myself (and a bit for others, e.g.volunteer work at the Ochsner Foundation Hospital). He also says that at age 82 he finally became a great-grandfather!—**Gordon K.Lister**, secretary, 294-B Heritage Village, Southbury, CT 06488

31

William Nixon III, retired, of Gates County, N.C., died July 31, 1992, at his home in Hertford, N.C. After graduating from North Carolina State University, he joined our class our junior year and, after graduation, stayed on to get a master's degree in mechanical engineering in 1932. After a short term in Ohio, he wound up with the Tennessee Valley Authority in Knoxville, Tenn. In 1940, he was assistant materials engineer.

During World War II, he spent three years with the Tennessee Eastman Co. where he worked on the electromagnetic process for the separation of uranium for the atomic bomb (Manhattan Project). He then returned to TVA where he was assistant chief inspector, Testing Branch, Tennessee Valley Authority, later becoming chief materials engineer, from which he retired to Hertford.

Nixon was active in numerous community organizations, including Perquimans County Restoration Society, which restored the oldest house in North Carolina. In 1938, he married Catherine Booker, and they had a daughter, Cynthia N. Mastro, now of Indiana, Pa.; a son, William Nixon IV, of Birmingham, Mich.; and three grandchildren, all of whom survive him.

Charles Sanders, the son of **Robert "Bob" Sanders** reported that Bob died on May 31, 1992. Bob is well remembered by all of us, as he was

always into one or more of the activities around the Institute, winding up as general manager of Combined Musical Clubs. He also served on the Institute Committee and was Field Day marshal our senior year. He worked in aeronautical engineering all his life, including being a design and maintenance engineer and test pilot for Encoupe, which he eventually owned and later sold. During World War II, he served in naval aviation, retiring as a commander. He also served as a consultant to FAA and was chairman of the board of Helicopter and Airplane Service Corp., Gaithersburg, Md. He flew his own airplane until 1979. He is survived by his wife, Emily, and I presume by his son, Charles, and three other children, as well as grandchildren.—**Wyman P. Boynton**, secretary, 668 Middle St., Portsmouth, NH 03801, (603) 436-1309

32

Minot R. Bridgham writes that three significant family events combined to keep the Bridghams from attending our 60th. His two grandsons graduated from two different schools—one is a dentist—and his oldest granddaughter had a June wedding scheduled.

Minot and Norma Bridgham, '32

Minot says he has had a great deal of pleasure in his 20 years of retirement, however the last four years he has required a good deal of medical attention. Angina was confirmed last spring and is most notable now by shortness of breath. He still bowls and plays a bit of golf. He sends best wishes to his classmates and if God is willing, he'll join us at the 65th.

John Brown and I attended the MIT Alumni/ae Leadership Conference (ALC) on September 19. The Institute feels it is important to have all volunteer workers for MIT come together and learn something about the problems—and opportunities—in running the affairs of such an establishment. I would say the effect on us was good. Science policy is at a watershed point. The last 50 years was an unusual period in which research could act as if there were unlimited resources. Not so now. Resources are limited. We must make choices and set priorities. (See p. MIT 5 for ALC report.)

One set of statistics impressed me and I pass it on to you. The Class of 1996 entering MIT numbered 1,148, including 402 women. Among them were 54 African Americans, 342 Asian Americans, 61 Mexican Americans, 11 Native Americans, and 75 students from abroad. The 553 white American males were a minority in the class.

We received the sad news that **Robert Freeman** died in February 1992, at home of cancer. Robert was a colorful Kentfield, Calif., resident whose vibrant life included stints as a ship's purser, chicken rancher, carpenter, photographer, painter, and advertising agency executive. When at MIT, he was captain of the varsity crew team, as well as class president. His first wife was a noted artist—**Evelyn Freeman**. His second wife, a noted graphic artist, died in 1984. Robert's son John, a neurologist in Tennessee said, "He lived life to the hilt right to the end." He also is survived by a daughter, four grandchildren, and two great-grandchildren.

We also learned that **Donald Sanford** died in April 1992. He was a retired engineer for the Bristol-Babcock Co. in Woodbury, Conn. He was chairman of the planning board of Woodbury. He is survived by two sons and two grandchildren. In July 1992, **Michael Anthony** died. He was production manager of Texas Instruments and for some years active in the nuclear division. Besides his wife, he leaves two children and two grandchildren.

Marian Hansen writes us that **Robert Hansen** died of leukemia on May 19, 1992, at the age of 81. His career in the sciences ranged from chemistry in shoe finishes to mathematics on the Apollo. He was a life-long student and an activist for social issues. He leaves his wife, Marian, three children, and five grandchildren—all presently college students. . . . **Richard Rafter** died May 1992 at Wolfeboro, N.H. He was employed as a chemical engineer with Grinnell Corp. in Providence, R.I., for 25 years. He was active in civic and fraternal organizations. He leaves two children and four grandchildren.

By this time you have read **Tom Weston**'s letter reporting on our 60th Reunion. His tapes do capture the spirit and the content of our reunion. I reviewed again the talks that our classmates made at the "open mike" session. For my secretarial work they are better than letters. From time to time I will use them for material in future Class Notes.—**Melvin Castleman**, secretary, 163 Beach Bluff Ave., Swampscott, MA 01907

33 60th Reunion

George Garcelon advises that **Otto "Put" Putnam** died August 26, 1992, in the retirement home in which he and Sally had been living for two years. George and Put worked for 40 years for Crompton & Knowles Corp. Sally Putnam may be reached at The Highlands, 2000 Cambridge Ave., Wyomissing, PA 19610. (George has been retired for 15 years—Elderhosteling, traveling, and volunteering. Both he and his wife are in good health. His address is 1126 Albright Ave., Wyomissing, PA 19610.)

C.D. Marshall, 625 West San Antonio, Lockhart, TX 78644, sends us a first term receipt from H.S. Ford, Bursar. Who can forget him? Tuition: $200. Required deposits: chemical breakage and military uniform $15 for all first year students; upperclassmen, graduates, and special people $25 for the chemical lab supplies. *How to Avoid the Five Dollar Fine*: Send your money by the specified date.

C.D. worked for variously the same company, alias Magnolia, Socony Vacuum, and Mobil, and then turned to farmer, rancher, traveler. He entered England as a "farmer," thinking it would expedite entry, and was asked what crops he raised. Reply: "A crop of four children," was his only successful one, leading to a long, friendly conversation.

Word from **Francis Vaughan**, Box 557, Tenants Harbor, ME 04860, concerning the bridge mastery of **Dave Treadwell**, 301 West 36, Wilmington, DE 19802. Both worked endlessly for Du Pont, retiring in 1973. The September 16 issue of the *New York Times*, in its Bridge section, within the *Arts for Saturday*, discusses one of the escapades involving Dave and his friends and his bridge.

It has been a mighty dry spell. Your reunion committee, however, is working diligently toward next June, our 60th! You will hear a lot about that between my writing this, September 25, and the January issue.—**William B. Klee**, secretary, Box 7725, Hilton Head Island, SC 29938

34

Basin Harbor, on beautiful Lake Champlain, was the site of our 58th Mini-Reunion. There were only 12 in attendance. **Al D'Arcey**, Dorothy and **Neal Karr**, Helen and **John Newbegin**, Anita and **Alex Rogowski**, Helen and **Dave Robbins**, and Mollie and **Carl Wilson**. **John Borger**, who was widowed two years ago, drove up from New Jersey on Wednesday to spend the day with us. He has a summer home at nearby Lake George, and he was headed for it when he left. Not quite as fleet of foot as he was as our stellar Lacrosse team goalie, he is still moving around pretty well. John retired from Pan-Am where he was VP in charge of global operations and maintenance.

Alex and Anita Rogowski have been faithful attendants at most of our Mini-Reunions. They have moved from New Jersey and are now living in a retirement home in Smithfield, R.I. Al has limited mobility and has to use a cane, but he still has that old fighting spirit, and it certainly does not keep Anita and him from moving around. They were bound for Point Au Fer when they left on Thursday to spend a week with the Newbegins.

John and Helen Newbegin, also faithful Mini-Reunion attendees, are both well and active and enjoying their home at Point Au Fer on Lake Champlain, where they now live year round. Helen worries a bit about John's vision while driving, but John is confident that he can see as much as he needs to see.

Dave and Helen Robbins, attended a Mini-Reunion for the first time this year. Dave worked for Raytheon on some of their major construction jobs. He then worked as an independent consulting engineer for Raytheon, supervising multi-million dollar construction projects all over the world. They have moved from Chestnut Hill, and are now living in Florida. Their trip North was combined with a visit to their children in the Boston area where they celebrated Dave's 80th birthday.

Al D'Arcey undoubtedly holds the Class Record for reunion attendance. He may have missed only one five-year Reunion, and last year's Mini-Reunion at Montebello. Al has a marvelous collection of VCR tapes not only of all preceding reunions, but also operas, choral groups, major events, etc. in his collection. Al is a daily golfer, and was disappointed that none of his regular '34 golfing buddies were on hand, particularly when there is such a beautiful 18-hole layout at Basin Harbor.

Fortunately, Neal and Dorothy Karr were in attendance for their first Mini. Neal and Al found that they had virtually identical handicaps. They played together Tuesday and found that they were as evenly matched as their handicaps indicated. Neal and Dorothy were married about six years ago. They divide their time happily between Marco Island, Fla., in the winter and the mountains of North Carolina in the summer. Neal, who was VP of all of Singer's manufacturing worldwide, spent about 12 years as works manager of Singer's plant in St. Johns, P.Q. He and Dorothy took advantage of his being so far North to visit his former plant. He was quite disappointed to find that the years had not dealt too kindly with it, and it was in a bad state of disrepair and inactivity. He was also unable to find anyone that he remembered still in St. Johns.

Carl and Mollie Wilson also divide their time between various locations. They live in Newton Highlands, Mass., but spend December through March in Coronado, Calif., and mid-June through August at Lake Chargoggagoggmanchaugagoggchabunagungamogg, at Webster, Mass. They had recently returned from an Elder Hostel at Lac Brom, Quebec, which they enjoyed very much. Carl enjoys his retirement from Foster Grant.

A much larger group had been expected. Leta and **Cash Belden** had been 100 percent Mini-Reunion attendees, and were looking forward to this one. Cash died suddenly on August 21st of a heart attack. He had spent most of his career in industrial relations. He joined American Optical as assistant to the personnel director shortly after Carl

Wilson went to work for them. He was senior consultant and manager of Canadian Operations for Industrial Relations Counselors, of New York, a world-wide firm. He had formerly been personnel director of Dominion Bridge Ltd. of Montreal. Cash and Leta were sorely missed by all who attended, and the Class will miss him at all its future reunions. For anyone who might like to write to Leta, her address is: 11 Pine View Heights, Brockville, Ontario K6V 6K3, Canada.

Three other couples who had registered had to cancel out at the last minute. **John Hrones**, our class president, who summers in New Hampshire, planned on attending, but a gimpy knee preventing him from doing so.

The advantage of a small group was that everyone became really well acquainted with every one else. The site was beautiful, the food and hospitality excellent. The group had a guided tour of Lake Champlain on the good ship *Discovery II*. The guide told us how important Lake Champlain was in the defense of the American Colonies. The British apparently planned on using Champlain as a roadway to Albany, N.Y., to achieve a pincer-like squeeze on the Colonies.

We also visited the Maritime museum at Basin Harbor. This is a real working Museum and most interesting. Besides all the artifacts and relics they have collected of the area, they specialize in recreating the various vessels that plied Lake Champlain. They built an exact replica of a sail-driven gun boat that had defended the western boundary of the 13 colonies. This is now in the water and on display at the Museum. The original which had sunk has now been raised and restored. It was then given to the Smithsonian in Washington, where it is on display. The workmen are currently engaged in building a replica of the original longboats used in transporting men and material on Lake Champlain. It is to be used in an upcoming movie to be filmed on Champlain.

Evening entertainment was provided from Al D'Arcey's VCR library. We had a marvelous recording of a choral group, and The Parade of the Tall Ships taken in Boston Harbor this past summer.

There will be no 59th Mini-Reunion. Our 60th will take place the first week in June and will revolve around Alumni Day on June 3, 1994. Results of the survey we did with our mailing last spring indicate about 45 of our classmates plan to attend. The majority indicated that they preferred that the Reunion be held on Campus. The Class seemed to be pretty evenly divided between staying in the dorms or a Cambridge hotel. Many locals indicated they would just as soon go home to sleep. There will be more details released from time-to-time, but meanwhile mark your calendar now to hold the first week in June, probably May 31 to June 5th, 1994, for our 60th Reunion.—**Carl H. Wilson**, Reunion Committee Chair, 48 Druid Hill Rd., Newton Highlands, MA 02161

35

I regret to inform you that **Willard F. Bixby** died of cancer on July 12, 1992, at the Mt. Sinai Medical Center in Ohio. He joined B.F. Goodrich's research department in 1936 and helped develop synthetic rubber, then transferred to the B.F. Goodrich Chemical Co. where he was manager of development engineering. He retired in 1976 but remained a consultant with the company until his death. He rowed with me on the MIT heavyweight crew and became a member of the Friends of MIT Crew, He was a member of the Civil Air Patrol during World War II and a member of the American Chemical Society. He is survived by his wife of 40 years, Jeanne, two sons, three daughters, and 11 grandchildren. I am sending our condolences to Jeanne.

For several months your secretary had been finding that he became tired rather quickly; I had made up my mind that nine holes of golf should be my limit. On Saturday, August 23, there began a series of events that explained my lethargy. I had angina pains that wouldn't stop with a drink of ice cold water, so I jumped into my car and drove 1.5 miles to Palomar Hospital Emergency Room. Within minutes I was placed under oxygen and had a nitroglycerin pill under my tongue, which stopped the pain. Next morning I was given an angiogram, which showed only one of my quadruple bypasses of 1976 was still working—one was partially open and two were closed. Since I was a member of Secure Horizons (HMO), I was transferred to Sharp Memorial Hospital that afternoon in San Diego. (They do an average of four open-heart surgeries daily.) After review, I was scheduled for the first opening at 8:30 a.m. on August 27, and the procedure was completed by 3:00 p.m. I learned later that I had had five bypasses instead of four, and the average life of a bypass back in 1976 was eight years. My 16 years meant I had been eating and doing the right things.

Currently I am living at the home of a very good friend, a retired teacher and now a hypnotherapist, Kay Fletcher, who came to my rescue when the hospital released me six days after surgery. I am motivated to continue my recovery so I can leave for Boston on October 13 for a long-planned visit to my four children, eight granddaughters, one grandson, and my sister in New Hampshire, plus Ginny and **John Taplin** and Sylvia and **Walter "Stocky" Stockmayer**.

I hope you have nothing as startling, but please write to **Allan Q. Mowatt**, secretary, 715 N. Broadway #257, Escondido, CA 92025

36

On a camping trip to Glacier Park, and Lake Louise in Canada, Phoebe and I visited **Don Spencer** (Course IX) in Durango, Colo. He had just received the 43-page galley proof of his biological memoir of Solomon Lefschetz, long-time Princeton professor and member of the National Academy of Sciences. Traditionally, the Academy publishes such memoirs of deceased members, written by their peers. Don's memoir is based on a long association—in the late 1940s Dr. Lefschetz twice invited Don to come from Stanford to join his Princeton math faculty. Later, Don did so, and in "24 happy years" at Princeton won an endowed chair of the department. He was voted a member of the National Academy in 1961. Don joined our class in 1934 as a junior after graduation from the University of Colorado, where he was Phi Gam. **Aaron Loomis** was one of his fraternal ties at the house on the Fenway.

In Salt Lake City I called Ken Cook, '39, who was '36 for three years and made many friends (May/-June '90 Notes). He was bedridden with the flu, but in our brief conversation recalled our serving together on the Walker Memorial dining staff, and what an "activity" that was! Hundreds of students in the Depression years and on into the '50s—commuters, dorm residents, and fraternity members—bonded by the need for meals and money, and inspired by the training and supervision of Bill Carlisle, '28. Even with all the private dining rooms and main hall busy for campus and outside groups (who can forget the big-tipping Massachusetts Safety Council?), Bill never lost his cool. He set a tradition with the annual Walker Assemblies Ball for staff, staff alumni, and invited guests only, "black tie requisite."

A letter from **Ken Winsor** in Italy includes: "We were happy to hear that you visited our close friends Anne and Jungle Jim (**Homer**) **Webster**—he was here almost 10 years ago. I'd love to see Maui again—incidentally, long ago I lassoed my Traute once and for all with a carnation lei (made it myself) in the middle of winter as she left to go skiing in the Alps."

When clearing out old papers, **Dick Denton** came upon a June 1937 *Boston Herald* lisiting the graduating class of 1937, many '36ers who got their SM, and **Robert B. Woodward** a PhD. Dick writes: "Bob did the bachelor's through doctor's in some minimal number of years and became a very famous organic chemist—first to synthesize some major molecules. The American Chemical Society

is putting up a memorial to him." . . . On the same page was a small item about Swampscott citizens' concern that the police were not enforcing the anti-kissing-on-the-beach ordinance. I forwarded this to **Lou Stahl**. His reply: "Dick brought back some fond memories—I was one of the chief culprits. In the summer of 1937 I met the most beautiful girl I had ever seen. The beach became our favorite necking spot. We were married a few years later. We frequently go down to the beach now and neck. The police still patrol but are concerned with cleaning up polluted areas, and they leave the kissing to the innocents. Dolly and I got a big bang reading about the old great times."

Cheers for the lives of **J. Lawrence Tobey** and **David Varner**! . . . "Tobe" died June 24 after a month of bronchitis, emphysema, and pneumonia. Previously he had been fully active in golf and tennis, and he treated wife Mary to a 15-mile balloon ride for their 40th anniversary in 1988. Tobe retired in 1958 as VP of Marden-Wilde Corp. (tanning oils) and during the last 15 years created and produced a special cheese sold in Boston and North Shore gourmet markets. Mary continues to be active in year-round tennis, yoga, and extended family gatherings at home: 5 Juniper St., Wenham, MA 01984.

A letter from Alvin Guttag ('40) tells of the August 24th death of Dave Varner, a fellow partner in Cushman, Darby and Cushman, Washington specialists in intellectual property law. "Dave was one of the top lawyers in the firm, a pleasure to work with, and above all a fine gentleman." Wife Mary Frances told of his getting the best of a rare bone-marrow cancer for 10 years, continuing with normal activities such as golf and only semi-retiring from the firm. She continues as a director of the National Cathedral Association, which financed the structure's completion when she was VP. She remains at 4302 Duvall Dr., Bethesda, MD 20816.

Gentlemen and ladies of '36 and overlapping classes: at our ages it is time to do "those things which we ought to have done." When you see the name of an old friend in these columns and say to yourself "I should write to him/her," do it! Keep a few 19 cents postal cards at hand, scribble a remembrance, and mail it at once. If you did not save your 50th or 55th reunion directory, mail it c/o your class secretary for forwarding. If it is a '36er, Pat or I will send word back to you with the address for further use.

Late addendum: Four days after the Hawaiian hurricane, Jim Webster in Kirkland, Wash., is unable to learn the state of his home on Kauai. But he is optimistic: "Over the years it has survived two tidal waves because reefs outside the bay break up the waves." For February we hope to have a full report on Florida (Andrew) and Hawaii (Iniki).—**Frank L. Phillips**, secretary, 1105 Calle Catalina, Santa Fe, NM 87501, (505) 988-2745; **James F. Patterson**, assistant secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

37

Eugene Cooper retired in 1988 from the Naval Ocean Systems Center, San Diego, Calif., where he was director of basic research. His main interest, in which he obtained a PhD from the University of California, Berkeley, is theoretical physics (atomic and nuclear). His new interest is astrophysics. He is an active member of the NCSD Institute for Continued Learning, which is an organization of retirees. His principal hobby is music, including playing classical compositions on his piano. He has four children and eight grandchildren and visits his family in Washington, D.C., Atlanta, and New Hampshire.

Charles Wetmore retired in July 1992 from the Miller Co., where he was a sales engineer. His interests are the stock market, BPOE, and the Masons. He has two children, four grandchildren, and six great-grandchildren. . . . **Roger Wingate** is retired from his position as executive VP of Liberty Mutual Insurance Co. He lives on the shores of Lake Winnipesaukee and enjoys boating, swimming, some fishing, and gardening. He has nine grandchildren and is currently working on restoring an antique boat built in the 1920s. He is still involved in several directorships and travels once or twice a year but loves winter in New Hampshire. He and his wife "Skippie" took courses at Oxford University two years ago. Both enjoyed our 55th Reunion, and they thank all who made it great, particularly, **Dick Young**.

It is with sorrow that I report the recent death of **Charles Palmer**. Charles was a retired rear admiral who earned a master's degree in naval construction at the Institute. He was a good friend of **Dwight Wrigley**, a Naval Academy graduate who received a master's from MIT. . . . **William Pattison** passed away June 28, 1992. He was an aeronautical engineer and was the executive VP, sales and service, for the Garrett Corp. . . . **Edna Cree** died June 26, 1992. She received a master's in public health from MIT.—**Robert H. Thorson**, secretary, 66 Swan Rd., Winchester, MA 01890; **Leonard A. Seder**, assistant secretary, 1010 Waltham St., 342B, Lexington, MA 02173

38 55th Reunion

Our principal news this issue is from two of our traveling class families. But first, I should correct a previous error:

Hold the Dates: June 1, 1993–June 4, 1993, our 55th Reunion. (*Not* June 7–12, as once reported.) **Norm Bedford** and his committee have arranged a full program for Tuesday and Wednesday (June 1 & 2) at the Harbor View Hotel, Woods Hole, Mass.; Thursday, we depart for "MIT Night at the POPS" (Symphony Hall) with pre-POPS dinner and post-POPS reception at MIT; Friday, June 4, is Technology Day on campus. Optional arrangements may be made for those arriving early or staying longer.

Paul O'Connell and Marie had a three-week trip to Italy. They started with a two-week Elderhostel program, primarily on modern Italian society, including art, cinema, and literature. The lectures were designed to take full advantage of the extraordinary beauty of the Umbrian and Tuscany regions. The program took place in Assisi, the birthplace of St. Francis. There the Basilica of St. Francis produces the most outstanding impression, with numerous frescoes by Raphael, Giotto, Perugino, etc. Assisi itself has a special atmosphere, characteristically medieval, as if time stood still within this walled city.

The program included two full-day visits to Perugia, the great center of Etruscan civilization. Of the other excursions, a definite favorite was Florence—the graceful city of red-tiled domes, bell towers, the Uffizi Gallery, Michalangelo's David, as well as delightful shops.

Paul and Marie took a week on their own, moving on to Rome. Most important and impressive were the visits to St. Peter's Square. On their second visit to St. Peter's Basilica, they arrived as Mass was in progress. That in itself would have been especially exciting for them, but they had an added advantage of being close enough to view the organist doing only pedal work in producing the outpouring of the tremendously beautiful organ.

Roy Hopgood and Alice had planned a spring Baltic cruise to preceed our mini-reunion at Endicott House. However, unexpected European business prevented their joining us. The business part of their trip had them 10 days in England, in Buckinghamshire, Hampshire, and Devon; 4 days in Verona, Italy; and 4 days in Germany. From there they flew to St. Petersburg, joining their cruise group for several days before boarding ship.

The whole trip took 33 days and 24 rolls of film. When the Severances visited them on vacation in August they were still far from sorting out their data and perspectives.

The exposure to Russia was their first, and needless to say, there simply wasn't enough time in any city. They stayed in St. Petersburg, Kronstat (the naval-base island downstream from St. Petersburg), and Vyborg, all of which are now in Yeltsin's Russia; Tallinn (the capital) and Saaremaa (a large island belonging to Estonia); Riga, the capital of Latvia; Kleipeda (the port city of Lithuania) and Palanga (the nearby beach resort); Kaliningrad, formerly Konigsberg, East Prussia, now belonging to Yeltsin's Russia; Gydnia and Gdansk of Poland. They ended their trip with a day at Rugen Island, a resort used by Hitler in rewarding party faithfuls—and finally the old German city of Lubeck. For anyone traveling in that area, he recommends Robert Massie's book, *Peter the Great*, whose army and navy dominated the Baltic.

Hoppy declines to name *the* highest point of the trip, but it is clear they felt particularly lucky to have been among the first "foreigners" ever to have visited the Naval Base Island of Kronstad. They were especially impressed by how keen everyone was in having them enjoy that visit, including a brass-band welcome at dockside, hospitable personnel on battleship, and even special entertainment at the Naval Officer's Club.

Into each of our Class Notes it seems a sad note must appear. This time it is the July 8 death of **Norman E. Weeks** at Cape Cod Hospital following a long illness. He had worked for Westinghouse and 38 years for Raytheon, and was a lifetime member of IEEE. In 1982 he retired from Concord to West Dennis.—**Don Severance**, secretary, 39 Hampshire Rd., Wellesley, MA 02181; **Ed Hadley**, assistant secretary, 50 Spofford Rd., Boxford, MA 01921

39

The Alumni/ae Leadership Conference was held September 19 at MIT to inform class officers and volunteers about major events affecting MIT and to bestow awards and honors on behalf of the Institute. Among about 450 attending were '39ers **Pete Bernays**, Lucille and **Oz Stewart**, and Hilda and **Hal Seykota**. (See page MIT 5 for ALC report.)

After lunch in Walker Memorial, 26 awards were bestowed upon 20 individuals, including two '39ers, and six organizations. Your secretary received the Harold E. Lobdell '17 Distinguished Service Award, which is given in recognition of alumni relations service of special depth over a sustained period. The citation reads: "For more than 52 years of tireless dedication to MIT, and for his unending commitment to the Class of 1939, travelling through 75 countries as well as the United States to maintain contact, including service to a number of MIT Clubs, and to the Association of Alumni and Alumnae of MIT."

The George B. Morgan '20 Award (given in recognition of sustained excellence in all aspects of Educational Council activity) went to **Burt Kleinhofer**, an active and loyal member of the Educational Council since 1967 and vice-chair since 1982. He has done a stellar job and has ensured that all the high schools in the region have MIT representation.

Yolande and **Ernie Kaswell** report Ernie's admission to the club of about two million persons in the U.S. who have pacemakers. His pacemaker, and mine, work fine and we send special thanks to classmates **Bob Schmucker** and **George Cremer** both of whom made technical contributions to companies then researching and developing pacemakers. On the subject of technical contributions, Ernie gave a talk two years ago on fibres. A listener came to Ernie afterward and invited him to consult on fibres with his company. Turned out that the company's main product was wigs. By now Ernie has strong connections in wigs, and I pass this info along to classmates who may be developing fringe-type haircuts. Our San Diego minister said once about his shiny pate: "In the beginning, the Lord made only a few perfect heads. The rest he covered with hair."

The *Miami Herald* reports that a new school, to be named "The Beatrice and **Irving Peskoe** Elementary School," will be constructed and ready for 885 students in 1993. It will provide relief from student overload due to nearby Homestead Airforce Base. IBM has promised computers for every room. Naming the new school after the Peskoes is in

recognition of their "tireless work for community education in South Dade." Since they arrived in the mid-'50s, they have been active in such campaigns as desegregating the public schools, creating such support organizations as the education committee of the Greater Homestead/Florida City Chamber of Commerce, leading a foreign student exchange program, and establishing a Homestead branch of Miami-Dade Community College.

A good news vignette originated from a Peskoe daughter who saw hurricane Andrew on her TV in San Francisco, phoned home, reported her hands-on prior experience during San Francisco's major earthquake, and declared, parents' objections notwithstanding,that she was flying in to help them. Irv introduced her to the over-burdened Federal Emergency Management Agency, which instantly accepted her offer to volunteer two weeks' work without pay. Within the two weeks the FEMA found the young lady indispensable and contracted with her to extend for six months. The Peskoe parents are proud of their daughter and overjoyed at the unexpected bonus of six more months of her company. Irv says he and Bea expect to attend the three-class mini reunion scheduled for January 4–7, 1993, in nearby Naples, Fla.

Aletta and **Bob Touzalin** live in Naples and volunteered to open their house during our January reunion to those who want to see and learn more about a magnificent antique English pewter collection. So far, Winona and **Wiley Corl**, **Roy Hayworth**, Anne and **Bill Murphy**, and Dora and **Paul Stanton** plan to attend.

Connie and **Manning Morrill** mailed an article from the September 20, 1992, *New York Times Magazine*, "Part Showman, All Genius." The article was adapted from "Genius: The Life and Science of **Richard Feynman**" to be published by Pantheon. In the article there are several mentions about Feynman's letter about quantum theory and mechanics to a college friend, **Theordore A. Welton**. A phone call placed me in touch with Ted Welton and wife, Jean, who live now in semi-retirement at Oak Ridge, Tenn., and who stimulated in me new wonderment and admiration for what they do.

Ted earned a doctorate after MIT, and Dick Feynman urged Ted to join him at Los Alamos where they worked together for several years. They and their wives became friends with Billie and George Cremer who also were at Los Alamos. Now, 40-plus years after all that and in semi-retirement, Ted's achievements have earned many honors and recognitions in the realms of quantum theory and mechanics, including the Alexander Von Humboldt Senior Scientist Award. Ted has written two book chapters and about 30 technical articles. Ted knows the theory of gravity, based on known aspects of the universe, and he continues to test his proofs on colleagues at Oak Ridge. He enjoys hacking and has hooked up his computer to several music keyboards.

I observe Feynman and Welton are judged to be close to genius rank. The rest of us 80,000 MIT living alumni/ae are ordinary mortals, especially advantaged because MIT's contributions to optimizing our capabilities enabled us to produce many superior achievements.

Mary and **Jim Barton** expect to attend a conference of Sloan Fellows October 13 at MIT.

The Emma Rogers Society, Room E38-202 at MIT, Cambridge, MA 02139, was established to help widows whose husbands were alumni or faculty of the Institute. Seminars are scheduled for May 5, 1993 (Retirement and Estate Planning: Protecting Yourself and Your Family) and May 6, 1993, (The Media Lab and More). For details please write directly to Betsy Millard, address above.—**Hal Seykota**, secretary, 2853 Claremont Dr., Tacoma, WA 98407

40

By the time you read this, the mini-reunion in Naples, Fla., will be history. At the time of writing, it appears that it will be very successful. When I have the full information, you will get a report.

Donald Cole writes from La Habra Heights, Calif., "I have settled into the retirement routine since transition in 1987. I keep occupied with family genealogy research, stamp collecting, and low key civic activities. My wife, Betty, and I are kept busy with travel and a big family of children, grandchildren, and great-grandchildren (28 so far)." Don included a clipping from *Linn's Stamp News* describing a new invention by **Alvin Guttag**. The patent issued relates to a method of protecting a stamp item from alteration, and of preventing the fraudulent reuse of stamps. The article goes on to describe the various embodiments of the invention. As a retired patent attorney, Al has written a number of things about how to invent and develop a product, by putting ideas to use.

Separately, Don Cole sent a clipping from *Aviation Week & Space Technology* that announced that the Airports Assn. Council International for North America named **R. Dixon Speas** (of Tucson, Ariz.) as 1992 William E. Downes, Jr. Memorial Award recipient. He is cited for his more than 50 years in aviation-related endeavors worldwide.

A one-time class member, who transferred to and graduated from Boston University, **William W. Pomeroy**, passed away on July 14, 1992. After service as an Army Air Corps pilot during World War II, he spent most of his life as a journalist. He retired in 1980 as news chief in NASA's Public Affairs Division.

I recently has a phone call from **John Parnell** of Yardley, Pa. John was visiting in Needham (my town) babysitting with grandchildren. As I was not at home, I did not have an opportunity to speak with him.

I welcome your letters and telephone calls. Keep them coming to **Richard E. Gladstone**, secretary, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

41

Chet Hasert reports, "There was a mini-reunion of 41-XVI (reinforced) at Harriet and **Bill Lamar's** beach house in N. Bethany Beach, Del., in September. **Connie Nelson** came in from Minneapolis, **Chet Hasert** from Fairfax, Va., and **Ed Hayes** and wife, Marie, from their nearby home in Broadkill Beach, Del.

"Bill is convalescing after a triple bypass, and though officially retired, still consults. His summer office is on the top deck of his beach house, where he alternates between a beautiful view of the surf and the monitor of his computer, complete with modem, Fax, copier, files, etc. He's currently working on a history of the X-29 (a research aircraft with swept forward wings) in which he and **Mal Absug** played leading roles. His vacation time is still mixed with business calls from Ohio.

"Ed Hayes was on several conference calls, renegotiating a treaty with the Indians of northern Ontario who are making claims on territory that includes his cabin on Bear Island, Lake Tomogama, in northern Ontario. His wife, Marie, earned just fame as coxswain of one of the eights at our 50th reunion row. She also steered a boat at the 45th.

"Connie and I, really retired, relaxed on the beach, and enjoyed the surf.

"Bill goes back to Dayton, Ohio, in October; Ed to his winter digs in Guadalajara, Mexico.

"The 'MIT-41-Four' crew that rowed weekly on the Potomac last summer has had to disband. Besides losing **Charlie Butt, Bob (Wilson) Blake** moved from Falls Church to Richmond, Va. That left only three of us: **Erling Hustvedt, George White,** and me. We row singles from time to time."

Chet adds that problems in moving into a new house and fixing up and selling his old one, has delayed his appeal to Charlie Butt's old crewmates and other associates to place a Charlie Butt '41 Memorial Shell at the MIT Boat house. This should come out shortly after he unpacks his boxes of records, computer, etc. in his new house.

A faithful correspondent, **Larry Turnock** writes that **John Sexton** suffered a stroke in July while recovering from a coronary bypass operation in April. We did not note Larry's earlier report because of the lead time and John's expected quick recovery from the bypass. I have verified with John's wife, Marge, that he enjoys hearing from his friends, during his long recovery period from the stroke. John's address: 50-D Lake Street, Winchester, MA 01890. We all wish our former president and tireless organizer of the 50th Reunion, the best.

Larry also enclosed a full page color picture of **George White** in front of the U.S. Capitol, from the Style Section of a Cleveland, Ohio, newspaper. George, a Cleveland native, and only the ninth person to serve as Architect of the Capitol since 1793, recently received the distinguished public service award from the Cleveland Club, a Washington D.C.-based organization of Cleveland supporters. His career, including responsibilities at the Capitol, was reviewed in the November/December 1991 issue of *Technology Review*.

A note from **Harold Radcliffe** of North Redington Beach, Fla., enclosed an obituary of **James F. Healey**, a civic and business leader of St. Petersburg, who died there on August 29, 1992. A Course II and Advanced ROTC graduate with us, he served in the U.S. Air Force at Wright Field, in Dayton, Ohio during World War II. Remaining on active duty for 13 years and achieving the rank of Colonel, he received an MS from MIT in 1948. Much of his early military career was spent in development of guidance and navigation systems at the Wright Air Development Center, Dayton, Ohio, and the Air Research and Development Center, Baltimore, Md. After resigning from the Air Force he held executive positions with ITT (Defense & Space), Bell Aircraft, Minneapolis Honeywell, the Singer Co., KMS Industries, and Florida Federal Savings & Loan. In 1974 he joined Milton Roy Co. of St Petersburg, Fla., a half century old manufacturer of health care products and special valves and instruments to control and analyze fluids. In 1986 he resigned as chair, remaining a director and member of key board committees.

As a retired Colonel, Jim was active in the Air Force Reserve and was a member of the Scientific Advisory Board to the Chief of Staff of the Air Force.

He was very active in civic affairs. As a self-described "frustrated ballplayer" (catcher) at MIT, he was more recently instrumental in planning the Florida Suncoast Dome, which attracted publicity when the San Francisco Giants agreed to play there next season. He also had an interest in the arts as a member of the group planning the Salvador Dali Museum in St. Petersburg. He later became president of the Salvador Dali Institute, which governs the waterfront museum with its A. Reynolds Morse Collection of works by the Spanish surrealist.

Jim is survived by his wife, Madelon, two brothers, two sons, and two grandchildren. The members of the class expresses our sympathy to his family.—**Charles H. King, Jr.**, secretary, 7509 Sebago Rd., Bethesda, MD 20817, (301) 229-4459

42

Summer is over and class news is at an all time low!

I received a note and an interesting article from *Builder's Magazine* about **Bob Chappelle**'s mud houses. He builds using polystyrene boards for framing and follows insulation with a surface of earth mixed with Portland cement. The final exterior coat is a clear water repellent. The first structure is 2,000 square feet consisting of four domes connected by arches. Anyone interested in living in a mud house, get in touch with Bob at 154 Main St., Montpelier, VT 05604.

Jean and I will again be in Clearwater from mid-November till the end of April. Our address there is: 2222 Americus Boulevard, North, Clearwater, FL. We offer golf, tennis, swimming, or just sitting on the beach.—**Ken Rosett**, secretary, 281 Martline Ave., Tarrytown, NY 10591

43

50th Reunion

I must apologize for missing the December Class Notes. A sudden attack of dyslexia caused me to enter the deadline in my calendar as August 31, instead of August 13. I will attempt to catch up.

One of those minimal notices from the Alumni/ae Association brings word that **Russell J. Bowen** died August 9 in Arlington, Va. He is survived by the friend who reported his passing and by some unnamed cousins. We grieve for the loss of a classmate.

Jim Casserly (Course XV) sent a note from Glastonbury, Conn., telling of his retirement. He now devotes his time to an extended family of eight children and eight grandchildren, a part-time staff position with the local community college, membership on the boards of the town art guild and fine arts commission, and square dancing. He also enjoys traveling, and looks forward to doing more of it upon the retirement of his wife, June. The 50th Reunion is prominent on his schedule.

Speaking of which, the Reunion Gift Committee met in Cambridge at the time of the Alumni Leadership Conference in September, with 13 out of 14 members present. Under the exacting chairmanship of **Stan Proctor** we discussed gift goals and techniques of personal solicitation. Reunion Committee Chairman **Ralph Leader** reported on the plans for next May/June, which will challenge your imagination. Gift and Reunion details will be sent to you from the appropriate soucres.

I picked up a number of personal news items at the committee meeting. President **Jim McDonough** continues his association with a small electronics firm in Wakefield, Mass., and tries to keep up with the development/preservation of Walden Pond.... Treasurer **Hans Walz** has acquired a one-man scull which he rows around his personal lake in New Hampshire.... Former class prexy **Ken Warden** has retired south to within a half-block of Rhode Island, where he engages in human resources consulting.... Past Alumni/ae Association President **Chris Matthew**, in his travels on behalf of MIT has accumulated enough frequent flier miles for a first-class seat to Mars.... **Burt Angell** has retired from G.E.... **Paul (Russ) Coulson** oversees, from Denver, a far-flung civil engineering enterprise.... **Gene Eisenberg** is busy in Boston with building construction and real estate.... **Bob Gunther** has moved to Puerto Rico, leaving the family business in the hands of his children in Connecticut, whom he visits from time to time.... **Charles Lawson** serves as trustee chairman for Colby College in New Hampshire.... **Hugh Parker**, thought to be a confirmed expatriate in London, now lives in Marblehead, Mass., and works with MIT's Industrial Liaison Program.... **Leo Feurer** is doing his best for the Reunion Gift campaign.... Stan (the Man, himself) is a trustee of Hiram College (Ohio) and John Cabot International College (Rome, Italy). Yes, he passes the hat for them too.

Happy New Year, as the Reunion countdown continues.—**Bob Rorschach**, secretary, 2544 S. Norfolk, Tulsa, OK 74114

44

Miguel C. Junger, chair of the board of Cambridge Acoustical Associates, Inc., Cambridge, Mass., will receive the Per Bruel Gold Medal of the ASME during its Winter Annual Meeting, November 8–13, in Anaheim, Calif. Honoring Dr. Per Bruel, who pioneered the development of highly sophisticated noise and vibration measuring and processing equipment, the medal recognizes eminent achievement and extraordinary merit in the field of noise control and acoustics. Miguel is receiving the medal "for seminal work in the field of interaction of sound and structures and for extensive contributions to the field of noise control." Miguel earned an SB and SM from MIT in 1944 and 1945, and in 1951 he received an ScD from Harvard. He worked as a research fellow at Harvard Acoustics Research Lab for four years before founding Cambridge Acoustical Associates with his colleague, Dr. P.W. Smith, Jr. in 1955. Even though he served as president from 1959 until 1989, he remained active in research. He also was active as an educator, serving as senior visiting lecturer at MIT's Department of Ocean Engineering from 1968 to 1978. He co-authored a monograph, *Sound, Structures and Their Interaction*, and a French textbook, *Elements d'Acoustique Physique*. He has been published in the *Journal of the Acoustical Society of America*, the *Journal of Underwater Acoustics*, *Noise Control Engineering Journal*, and the ASME's *Journal of Applied Mechanics*. An ASME fellow, Miguel is a registered professional engineer in Massachusetts. Congratulations, Miguel.

The Alumni/ae Leadership Conference was held at MIT on September 19, 1992. In attendance were **Virginia Barber, Andrew Corry, Louis Demarkles, Edgar Eaton, Jr., Caspar Schneider, Norman Sebell**, and **Melissa Teixeira**. The class was honored when class president **Ed Eaton, Jr.**, received the award of the Bronze Beaver in recognition of distinguished service to the Institute. It is the highest honor the association can bestow upon a member. Since the award was established in 1955, fewer than 200 alumni/ae have received it. Ed was a Leadership Campaign vice-chair, worked vigorously for the 40th Class Reunion Gift, and has given generously of his time as well as finances. While being actively involved as a volunteer for the Campaign for the Future, Ed also chaired several Alumni/ae Fund Visit Programs. He has served as a member of the Alumni/ae Fund Board and is a key volunteer in northern New Jersey for both the association and the Institute at large. The class salutes you, Ed, for earning this most distinguished award.

We note with deep regret the passing of **Robert V. Coleman** on January 9, 1992. Bob was retired and resided in McLean, Va. We extend our sympathy to his wife, Ruth, and family.... In early August on beautiful Cape Cod, a gathering was held at the home of Jane and **Bob Barnaby** in the quaint village of Cotuit. In attendance were Marguerite and **Ed Ahlberg**, Mary and **Bob Clarke**, Diane and **Andy Corry**, Jane and **Lou Demarkles**, Dorothy and **John Gardner**, and Helen and **Larry White**. A toast was made to the class.—Co-secretaries: **Andrew Corry**, P.O. Box 310, West Hyannisport, MA 02672; **Louis Demarkles**, 77 Circuit Ave., Hyannis, MA 02601

45

Please send news for this column to: **Clinton H. Springer**, secretary, P.O. Box 288, New Castle, NH 03854

46

Coincidences crop up and I may find myself in a small reunion. Such came along a day or so ago when my wife, Bettie, who booked a trip back east the end of September to join her 50th high school reunion in the little town of Woodstown, N.J. The other day she was invited by one of her classmates to visit her home on the beach at Brigantine, north of Atlantic City. Then it occurred to me that I had been invited by my classmate, **Bob Hoffman**, to visit him (and Marion) at the seashore by Barnegat Bay. The thought dawned on me that I might be able to revisit a bay where I had spent days fishing and duck hunting in my teenage years. It remains to be seen if this connection merges in the latter part of the 1992 fall. I'll let you know what happens.

The other lonely item I promised in the Nov./Dec. classnotes was that of the letter relay between **Jim Chabot** and **Stan Young**. Jim's letter was mainly a reminiscent *billet doux* of years gone by. Then I received a nice letter from Stan shortly

after sending Jim's. Here he tells of his soft retirement, aging gently, if I read it right, with trips to the Adirondacks where his eldest daughter has a cottage, and going fishing off Montauk. He also tells of the other two lads and daughter and his seven grandchildren, which was good to keep track of. And that's the size of it all. Maybe in the next issue we'll have some busier holiday news.

KEEP SMILING.—**Jim Ray**, secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

47

45th Reunion notes—final installment! . . . **Jack Rizika** has had a fascinating and varied career. He went into a G.E. training program upon graduation. Later, he had an R&D business (Northern Research) in the gas turbine field. He sold that to Ingersoll Rand about 1970 and has been involved in real estate, finance, and mergers and acquisitions since—usually real estate and usually related in some way to MIT. Since the late '70s, Jack and Karen have been living six months of the year in Israel and the other six months in Boston.

Ed Rosenberg taught for 30 years at Western Connecticut State University; he retired in 1989. Since then he's been traveling and taking care of grandchildren. Ed and Harriet have six children (half hers and half his) and ten grandchildren. They live in Danbury, Conn. . . . **Leon Scharf** was technical director for the Navy in computer procurement until his retirement eight years ago. He had also been a professor at George Washington University. Now he's a student again! He's been studying chemistry for the last five years at the University of Maryland. He's also been writing poetry and has had several poems published. Leon and Florence have been married 45 years and have three children and three grandchildren.

Art Schwartz "retired" in 1988 and then worked for Boise Cascade in Hawaii for a while and also is doing some consulting. Art promises a letter one of these days with more detail. Incidentally, Art and Pat Knodel (whose husband is an alum) entertained us at Tech Night at the Pops with some spirited jitterbugging to "In the Mood"! (Society note—Ex-Governor Dukakis was also at Tech Night at the Pops, but not with us.) Two weeks after our reunion, Ann and I were in California for a nostalgic visit to the *Queen Mary* and we had dinner with Art and Margie on the *Queen*!

Harry Sherman retired four years ago from Wagner Electric; he and Betty live in North Caldwell, N.J. At one point, Harry was involved with Tung Sol, an old competitor of mine when I was in the CRT business with G.E. . . . **Reid Smith-Vaniz** and Joan attended from Darien, Conn. Reid is a consultant in electrical engineering. They have four children with four very different careers. Their 35-year-old daughter is a pathologist and is currently doing her residency in psychiatry at a New York City-area hospital. Will, 31, is a software engineer. Tom, 29, is in Lyons, France, "trying to learn enough French to teach English in France." Jane, 27, just got a master's in education from the University of Virginia and will be looking for a teaching job to support a horse and two dogs.

Phil Solomon retired from TWA as a flight engineer in 1985. Since then he and Frances split their time between Cape Cod and Florida, sailing back and forth. Their oldest son is a professional inventor who divides his time between Cape Cod and Belgium. He and his Belgian wife have a 1-year-old daughter. Second son, Murray, is an engineer in central Massachusetts. . . . **Parker Symmes** and two associates started an architect/engineering firm—Symmes, Maini, & McKee—in 1955. Parker sold his interest several years ago but is back working for the firm full time in the HVAC area. Significant clients have been IBM, L.L. Bean, and Talbots. (The firm did the L.L. Bean store and warehouse in Freeport, Maine.) Parker and Midge have five children, ages 31 to 35. The reason for the narrow age range is that both Parker and Midge were widowed, so the children are "his and hers." They have five grandchildren with two more "in process" at the time of the reunion.

Don Van Greenby was a builder and land developer until he retired several years ago. Now he's back in the development business building "affordable housing single-family homes." Don lives in Lowell, Mass. . . . **Fred Veith** retired four years ago from Pfizer International, where he was VP of Manufacturing. He was involved with plants in 100 countries, among them the United Kingdom, France, Brazil, Argentina, and Japan. Fred and Cornelia live in Old Greenwich, Conn., and have three children and four grandchildren.

Other news. . . . My phone rang recently one morning and it was **Mike Hardy**. Mike was one of my housemates at the Student House and he and I wrote our thesis together! Mike has been retired for 11 years. He and Marian each have 4 children (Mike was widowed many years ago and is remarried) and a collective 15 grandchildren. They were in Denver to visit one of Marian's children. Unfortunately, they were at the other end of the (large) Denver metro area so we couldn't visit.

John Truxal, Distinguished Teaching Professor Emeritus at the State University of New York at Stony Brook, recently received the 1992 Sterling Olmsted Award from the American Society for Engineering Education. The award was presented in recognition of his contributions in the teaching and administering of liberal education in engineering education.—**R.E. (Bob) McBride**, secretary, 1511 E. Northcrest Dr., Highlands Ranch, CO 80126

48 45th Reunion

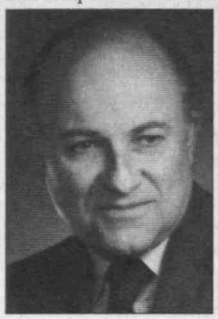
Verity Smith and his wife, Anita, invited classmates in Massachusetts, Rhode Island, and Connecticutt to their home in Little Compton, R.I., last August. Attending were: Jean and **Milton Slade**, Virginia and **George Clifford**, Eleanor and **Harold Ottobrini**, **Frank Guptill**, Laura and **John Morrison**, Gloria and **Herb Lipson**, Gloria and **Sonny Monosson**, Nancy and **Don Noble**, Genie and **Dave Finnegan**, Jean and **Bob Turkington**, **Jeanette Fantone**, **Mike Oglo**, Joan and **Sam Hanna**, Beatrice and **Don Perkins**, and **Marty Billett**. Also, Eliza Dame of the MIT Alumni/ae Association and her husband, Doug, were our guests. **Milton Slade**, chairman of our 45th Reunion, and Eliza presented reunion plans to the group.

The party helped to publicize our upcoming reunion in June 1993 and gave us the opportunity to continue the killer croquet matches we began five years ago. The weather cooperated and Verity and Anita's large grassy yard was the scene of another battle. Then, Harold Ottobrini and George Clifford played tennis at the adjacent court. We enjoyed cocktails in a large sunny room. The guests shucked corn, and Verity boiled it to complete a great buffet with lobster salad, fresh tomatoes, hamburgers, and Verity's freshly baked cinnamon rolls.

After dinner, Laura and John Morrison described how they cut Norbert Weiner's class on a Friday afternoon to get married. John had been drafted in his freshman year and returned to MIT after the war. Laura (Christensen) was a chemical engineering major at MIT. After a weekend honeymoon, they attended class on Monday. When money became limited, Laura dropped out and became a working wife. While they lived in Westgate West, Laura gave birth to their first child. Later John worked for General Foods in White Plains, N.Y., and Laura was director of the Health Lab in Greenwich, Conn.

Ed Kosower, who holds the Josef Kryss Chair of Biophysical Organic Chemistry at Tel Aviv University, is one of three authors of a text, *Introduction to Organic Chemistry*, published this year by Macmillan. The book is being used at Harvard, Yale, Columbia, Brown, and Stanford, and is considered the premier text of organic chemistry. . . . **Dave Kingery** recently served as editor of a new book, *Technological Perspectives on Behavioral Change*. Dave has dual appointments in anthropology and materials science at the University of Arizona.

Dick Berry died last August. He devoted his entire 43-year career to the Rogers Corp., which he joined after graduation. He was senior VP for technology, where he guided the development of new products and had an important influence on the use of polymers in the company's specialty materials and components. The company's president once said, "Dick Berry's contributions touch everything we do. Our technical discoveries and advances, our products and processes, our management practices, and our company's character, all have his imprint." Dick was awarded numerous patents and had published extensively in professional journals. Active in many professional organizations, he chaired a committee on dielectric materials of IEEE. He was instrumental in the creation of a community college in the northeastern corner of Connecticut and served on several state boards for Connecticut's colleges. Dick and his wife, Louise, had been living in Danielson, Conn.



Richard Berry

Earl Hoyt died in Menlo Park, Calif. . . . **Manfred Wentzel** died in Indian Harbor Beach, Fla. . . . **Bruce Gaviller** died in Lockport, N.Y. . . . **Melvin Deroche** died in Portland, Maine. On behalf of our class, I extend our sympathy to the families of these classmates.—**Marty Billett**, secretary and president, 16 Greenwood Ave., Barrington, RI 02806, (401) 245-8963

49

Those of you with an eye to the future will be glad to know that your Reunion Committee toiled without cease in the harsh surroundings of Stratton Mountain Inn at Stratton Mountain, Vermont, over the weekend of August 14–16. They were planning the off-campus portion of our 45th Reunion. Mary and **Tom Toohy** hosted the three-day affair and the toilers who joined them were: Ruby and **Len Newton**, Jean and **Harry Lambe**, Eunice and **Joe Schneider**, and Roz and **Stan Margolin**. Two momentous decisions were reached. The first was that the affair would be held at either The Elbow Beach, The Princess in Southampton, or The Castle Harbor—all of these being resort hotels in Bermuda. The second was that 4-day and 7-day quotes would be requested from the stateside representatives of these three world-renowned establishments. Stan and Roz were asked to obtain the quotes. The committee will have had another session before these notes reach you.

At the Alumni/ae Leadership Conference (ALC) held on campus in September, **Ingram "Ike" Lee II** received the George B. Morgan '20 Award. This award is given "in recognition of sustained excellence in all aspects of Educational Council activity, including dedication to MIT, an abiding concern for and sensitivity to the best interests of prospective students, and exceptional standards of achievement and professionalism in the execution of Council responsibilities." Ike hails from Dallas, Tex., where he is headsthe materials management service for Texas Instruments. In describing his duties to me, Ike said: "Just call me the chief truck driver."

An article in *Living Church* dated June 7, 1992, describes the extraordinary and heart-warming achievements of **Dave Hardin**. I take the liberty of drawing at length from this moving account.

After Dave had earned an MBA in market research from the University of Chicago, he joined the five-year-old firm of Market Facts where his presence raised the head-count from seven to eight. By the time he left the firm as its chairman of the board, he had seen it grow to become one of the top four organizations in the country. Although doing very well in business, Dave became interested in helping others through work in the ministry. These concerns may have been heightened by the fact that his wife had, for years, been desperately ill with multiple sclerosis, from which she eventually died. Through study at the Seabury-Western Theological Seminary in Evanston, Ill., he became an Episcopalian deacon.

Dave's life took a new direction when Market Facts went public, leaving him with enough money to devote full time to work that he thought could make a difference to other people.

Soon, he became president of the Sunday Evening Club, based in Chicago and known nationally by the title "30 Good Minutes." It is the longest continuous series in American television. Meanwhile, a former client of Market Facts, Al Whittaker, had left the presidency of The Mennen Co. to found Opportunity International, an organization devoted to generating "employment by providing small business loans, training, and support to those in need." Dave joined the outfit as a fund-raiser and finally succeeded Mr. Whittaker as president.

In 1989, Opportunity International made loans totalling $4.1 million dollars, creating 9,701 new jobs. At last report, it had helped 64,624 persons and more than 90 percent of the loans have been repaid.

"One project particularly touched me," Dave says. "It was a loan of $1,400 to Maria Gonzalez of Honduras to manufacture stuffed animals. . . . When I last visited the project, she had paid off her loan and had six regular and eight seasonal employees. Maria, her husband, and three children had been living in the back of an abandoned station wagon prior to receiving the loan."

One of the experiences which has left its mark on Dave is him memory of a 7-year-old girl asleep on the steps of the cathedral in Tegucigalpa, the capital of Honduras. She was protected from the weather by only a thin, filthy dress, and was using her sandals for a pillow. Her parents had abandoned her because they could not feed her. Ever since seeing that girl, Dave has been haunted by the thought of what she will have to go through in growing to adulthood. For families like hers, Dave feels that Opportunity International can make the difference that aid from our federal government never seems to.

Recently, Dave has learned that he has chordoma, a tumor at the base of the spine. This type of growth seldom spreads but is untreatable. However, Dave is too busy with the Sunday Evening Club and Opportunities International to have much time for worry.

Now, to a topic that concerns our own community. Many of our alumni have wives who are just as interested in Tech as they are. These wives come to meetings with their husbands, pitch in whole-heartedly on committee work, and make lifelong friendships with those whom they meet through Institute activities. In short, MIT becomes a part of their lives.

Suddenly, if a husband dies, the surviving spouse may come to miss the people and activities she formerly enjoyed. Enter the Emma Rogers Society. Founded in 1990, the society provides widows with continuing membership in the MIT community and a chance to contribute their quite considerable talents to the benefit of the school. A well-done newsletter is published, and activities, programs, and seminars fashioned specifically for Emma Rogers members are made available throughout the year.

I think I may have been present when the concept of the Emma Rogers was first enunciated. It was a meeting of the class of 1948, when Dorothy Seltzer, widow of Norman Seltzer, '48, spoke eloquently about the plight of widows. When I got home, I called George Clifford, '48, to say that something should be done in response to Dorothy Seltzer's plea. George agreed and so, apparently, did many others because, in the winking of an eye, or so it seems, this wonderful society has sprung into being.—**Fletcher Eaton**, secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

50

Please send news for this column to: **John T. McKenna**, secretary, P.O. Box376, Cummaquid, MA 02637

51

In 1990, after 30 years of service as a biophysics research director at the Lahey Clinic Hospital, **William A. Curby** joined the Federal Aviation Agency as an anti-terrorist research scientist. He entered this new position just in time for service during Desert Shield/Desert Storm. In addition, William became probably the most recent father among our classmates when Mathew Taylor was born in February 1991. His wife, Laurie, and Mathew join William by commuting from Boston to the FAA in New Jersey.

Our prior class president, **Bill Maini**, has been appointed to the board of directors of the MIT Alumni/ae Fund.

Your secretary attended a class secretaries' workshop at MIT in September. About 60 class secretaries and other class officers held a brain storming session on how to make use of our ever broadening access to computers and networking technology to better serve classmates and the Alumni/ae Association. The 60 or so ideas will be presented to a committee established to work on and develop these proposals. Perhaps in the near future, you will be able to have dialogues with others in our class through use of an alumni/ae bulletin board.—**Martin N. Greenfield**, secretary, 25 Darrell Dr., Randolph, MA 02368

52

Franklin O. Carta has been named VP of the American Society of Mechanical Engineers' International Gas Turbine Institute. In the past he has served as chair of the Institute's board. Frank has spent his entire career at the United Technologies Research Center in East Hartford, Conn., involved in aerodynamic research relevant to gas turbines.

Richard E. Cole was given the George B. Morgan '20 Award last September at the Alumni/ae Leadership Conference. The award is given in recognition for excellence in Educational Council activity. Members of the council, as you may remember, interview and advise prospective students on behalf of MIT.

Nick Haritatos thoughtfully sent me a copy of the note and group photograph he sent to our classmates from Course X (chemical engineering) who attended our 40th Reunion last June. Nick commented on the large turnout of alumni from that course—exactly one fourth of those who graduated. I also noticed the very good attendance by chemical engineers, and spent some time wondering why they, and alumni from civil engineering and building construction, and mechanical engineering, were so well represented, while electrical engineers seemed to me to be relatively scarce. The presence of a lot of business administration graduates did not surprise me, but I have no feeling for why there should be marked differences between various types of engineers. Of course the subsequent careers of many graduates has not been too closely related to their professional training, but considering that only raises more questions.

The questionnaire sent out last July by Class President **Bob Lurie** and Reunion Chairman **Stan Sydney** soliciting opinions about our last reunion and suggestions for the next one, produced an interesting response from **Bill Deane**. He mentioned that some classmates from the Far East thought it would only be fair to have one reunion closer to where they lived, and that prices are more reasonable in many places on the eastern rim of the Pacific. Bill is therefore plugging for a July reunion in Macao, the Portuguese colony close to Hong Kong, for our 45th.

Will we ever want reunions by video conferencing?— **Richard F. Lacey**, secretary, 2340 Cowper St., Palo Alto, CA 94301

53 40th Reunion

Please send news for this column to: **Gilbert D. Gardner**, secretary, 1200 Trinity Dr., Alexandria, VA 22314, (703) 461-0331

54

Please send news for this column to: **Edwin G. Eigel, Jr.**, secretary, 33 Pepperbush Lane, Fairfield, CT 06430

Last April, Paul Gray, '54, (second from the left) was honored with the Grand Cordon of the Order of the Sacred Treasures, one of Japan's highest awards. On April 29, celebrated as Greenery Day in Japan, the Japanese government awards its imperial decorations. Gray was decorated for promoting mutual understanding and friendship with Japan.

The important programs he created during his tenure as president and chancellor at MIT included the opening of the Industrial Liaison Program to Japanese membership, the establishment of the MIT Japan Program, which sent some 50 MIT students to Japan last year as interns to various Japanese institutions and companies, and a significant increase of visiting scientists from Japan. The award was presented at a ceremony at the home of Japan's consul general in Boston that was attended by Priscilla Gray and two other MIT officials who have been similarly honored by the Japanese, MIT President Emeritus Jerome B. Wiesner, left, and Professor Emeritus Samuel A. Goldblith, former vice-president for resource development.

55

John N. Rossettos, Course XVI, has been named a fellow of the American Society of Mechanical Engineers (ASME). The fellow grade is conferred upon a member with at least 10 years of active engineering pratice who has made significant contributions to the field. John is now professor of mechanical engineering at Northeastern University and resides in Winchester, Mass. He had received both bachelor's and master's degrees in aeronautical engineering from MIT, then went on to get a PhD from Harvard University in 1964. John is also a member of the American Academy of Mechanics.

Gerald B. Kliman, Course VI, was also recently elected as a fellow, in his case, of the Institute of Electrical and Electronic Engineers (IEEE), "for contributions to linear induction motors and liquid metal pumps, and to passive current fault diagnostics for electric motor systems." Gerry has been at General Electric's Corporate R&D Center in Schenectady, N.Y., since 1978, after tours at GE's Transportation Division (Erie, Pa.) and Nuclear Division (San Jose, Calif.) since 1971. Prior to that he had been assistant professor of electrical engineering at RPI in Troy, N.Y. While at MIT, Gerry married the former Edith Moses, of Wellesley College; they now have two sons, one of whom is completing a master's in mechanical engineering and the other is about to enter medical school. Gerry still plays the violin in a local community orchestra and is currently heading up a project, in cooperation with an inner city after-school art center, to try to stimulate an interest in mathematics among the children. The central theme is fractals, being approached on two fronts: one is a special musical presentation illustrating fractal constructions in sound, presented by the orchestra; the other consists of art projects, also based on fractals, carried out by the children in the weeks preceding the performance. The performance was video-taped with explanations and demonstrations of concepts at a suitable level for children. (I wonder how many of us could have followed it!)

Edward A. Bryan, Course III, Theta Chi, now operates a technical translation service in Philadelphia. He has eight colleagues, all engineers and scientists, who provide translations of German, French, and Russian engineering and scientific material. He also expects to be offering business translations in the near future. Ed is, himself, fluent in German and French and is now learning Russian. He is also active in hiking and classical music.—Co-secretaries: **Roy M. Salzman**, 4715 Franklin St., Bethesda, MD 20814; **James H. Eacker**, 3619 Folly Quarter Rd., Ellicott City, MD 21042

56

John N. Rossettos, professor of mechanical engineering at Northeastern University, has been elected to fellow grade in ASME. John's major contributions concern stability and vibration of plates and beams, crashworthiness, and adhesive joints.

Paul Cianci and **Lloyd Beckett, Jr.**, attended the Alumni/ae Leadership Conference at MIT on September 19. At this conference **Walter P. Conrad, Jr.**, and **David H. Mitchell** received George B. Morgan '20 Awards. The Morgan Award is given in recognition of the sustained excellence in all aspects of Educational Council activity, including dedication to MIT, an abiding concern for and sensitivity to the best interests of prospective students, and exceptional standards of achievement and professionalism in the execution of Council responsibilities. David attended the conference with his wife, Joan. They currently reside in Lawndale, Calif. David is a project manager at TRW Space & Technology at Redondo Beach, Calif.

Walter Conrad, Jr., is president of Conrad Bros., Inc., in Chesapeake, Va. . . . **Richard Jacobs**, a senior vice-president of our class, has been elected as the next president of the Alumni/ae Association. Dick is the senior vice-president of A.T. Kearney, Inc., Chicago, Ill.

As of this writing **Theo de Winter** is the Republican candidate for the Second Congressional District of Greenville, N.H. He wants to bring his technical insight to Congress with the qualities of an engineer, including the abilities to plan and to prepare. Theo is a professor of manufacturing at Boston University and co-founder of Magnetic Corp. of America.

Send news to **Ralph A. Kohl**, co-secretary, 54 Bound Brook Rd., Newton, MA 02161

57

Please send news for this column to: **John T. Christian**, secretary, 23 Fredana Rd., Waban, MA 02168

58 35th Reunion

Close your eyes and you can imagine it. The sunrise squinting through the pine trees, the waves crashing ashore on the rocky coast. You awaken at the Black Point Inn in Maine. It's your 35th Reunion and, after pinching yourself just to be sure, you realize you really are there!

Situated on historic Prout's Neck, jutting into the ocean, the Black Point Inn is secluded but only 15 minutes south of the center of Portland. With its charming New England architecture of gray shingles and white trim, the Inn is one of America's few remaining traditional resorts. In addition to its own sandy beach, the Inn also has a heated outdoor salt-water pool and a heated indoor fresh water pool. Next door is an 18-hole golf course and 14 clay and all-weather tennis courts. Portland's refurbished dock area, the Old Port District, is brimming with quaint shops and L.L. Bean is a short drive north of the city. So, you can spend your days on a wide range of activities and in the evenings you'll enjoy the Inn's gourmet dining and attentive service. Make your reservations early for a wonderful reunion weekend! Remember the dates: Friday, June 4, through Sunday, June 6.

Also, please send in your class dues of $19.58 (get it?) to help defray the costs of printing and mailing reunion notices to all classmates. (Feel free to round up to $20.00, by the way.) All dues-payers will receive a copy of the results of the infamous Class of '58 quinquennial questionnaire.

Reunions are a great time to see friends and classmates from the living group, course, or activities in which you were involved at Tech. Through the reunions, many of us have formed close personal and professional ties with classmates that we may not have known well at school. Even if it's your first reunion, your classmates and reunion committee look forward to welcoming you—"down Maine."—**Mike Brose**, secretary, 75 Swarthmore St., Hamden, CT 06517

59

Please send news for this column to: **Allan S. Bufferd**, secretary, Office of the Treasurer, MIT, 238 Main St., Suite 200, Cambridge, MA 02142

60

My very best holiday wishes to you and yours. May 1993 be one of much health, happiness, peace, and prosperity.

Kenneth Myers writes that his environmental law practice occupies most of his time. He also relates that his Tech education remains most helpful, "not for the artifacts of science or engineering that remain with me, but for the logical and orderly approach and understanding of the scientific method." (Your secretary strongly agrees; over the years I have benefited time and again from what I didn't realize at the time I was gleaning from the struggles with 8.01, 5.61, and 10.27.) Ken's Philadelphia firm, Morgan, Lewis, and Bockius, has recently published a new edition of the *Envi-*

ronmental Spill Reporting Handbook edited by Ken and others in his firm. Ken says his three kids are on their own—one an interning physician, another a doctoral candidate in literature, and the third a first-year college student.

Sheila Widnall continues to garner honors. Sheila, who is currently an associate provost and aero/astro professor at Tech, has been elected to the governing council of the National Academy of Engineering.

The *New York Times* noted the promotion of **Herbert Shanzer** from president to chairman of Alloy Computer Products Inc., in Marlborough, Mass. Congratulations, Herb.

As you look for places to lower the taxable income on your 1040, please don't forget the Alumni/ae Fund. The Institute (and your class agent) would be most appreciative.

Again, Happy Holidays!—**Frank A. Tapparo**, secretary and class agent, 15 S. Montague St., Arlington, VA 22204

61

You computer-nicks will be pleased to learn that efforts are under way to get the class secretary's office onto a network. Henry McCarl ('62), whose column follows this, has set up an e-mail box at MIT for his classmates to use. If you want to try his box, you can enter your message at SUB MIT1962 through Internet at LISTER@MITVMA.MIT.EDU or through Bitnet at LISTERV@MITVMA. I am going to try and set one up for our class as soon as I figure out how to get it to work from home. As I learn more I'll give you full instructions. At a meeting last September, Henry described the system and encouraged other classes to get involved. There was general agreement that the Alumni/ae Association was living in the pre-industrial era and it was time to catch up.

John O'Connell, head of chemical engineering at the University of Virginia, is a specialist in fluid thermodynamics and has been busy since he arrived there in 1988. He has been hiring faculty, building a new chemical engineering and biotechnology building, and hunting up money for endowed professorships. He is a fellow of the American Association for the Advancement of Science.

Since it's a slow news month, I want to solicit some help from you people. In October I will be traveling around the Southwest. Among the high points of the trip will be visits to the Trinity Site in New Mexico, where the first nuclear explosion was set off at 5:29:45 on July 19, 1945. I'm also excited about a visit to the Very Large Array radiotelescope south of Magdelena, N.M. Many of our friends think my enthusiasm confirms their belief that I'm very weird. Probably true. In any event, these kind of things are enjoyable to certain types of people—nerds. Perhaps a travel book for us weirdos might be of some interest, which brings me to my request. Can you suggest places to be included in a book to be entitled *The MIT Traveler*? On my current list are places like Carhenge in Alliance, Neb., the world's second largest hump yard (I can't find out where the largest is), and the Acushnet golf ball factory in Rhode Island. Any other interesting places rarely mentioned in *Fromer's* or the AAA guides? Write and tell me about them.—**Andrew Braun**, secretary, 464 Heath St., Chestnut Hill, MA 02167

62

The MIT Alumni/ae Association presented **James Stark Draper** with the Henry B. Kane '24 Award given in recognition of exceptional service and accomplishments in fundraising for MIT. Jim was also part of the America^3 Team in the 1992 America's Cup victory sponsored by classmate **Bill Koch**. The Kane Award was presented to Jim Draper at the MIT Alumni/ae Leadership Conference on September 19, 1992.

Received a nice letter from **Don D. Divinia**, Rt. 6, Box 269, Greenville, TX 75402; phone (903) 883-2276. Don's letterhead is D^3. Don wanted to come to the 30th Reunion, and while some provisions had been made to accommodate the handicapped, Don finds it difficult to travel with his folding manual wheel chair and has problems with cabs and busses with his electric scooter. Don writes that his disability has been diagnosed as Multiple Sclerosis (MS). His advice is, "Eat your dessert first, life is a gamble, but do your physics and math just in case you survive!" Don has two sons in college who will graduate in 1993 with degrees in mechanical engineering and computer science from Texas Tech and East Texas State. Don's wife has been taking good are of him and the family while teaching to pay for the boys' college educations. Don would especially like to hear from MIT friends with specific requests to **Ed Feustal**, **Robert Rabiner**, and **Bob Shieldkraut** from the Strobe Lab and "anybody who wants to write."

I know that Ed Feustal will get this message since he is on the MIT1962 e-mail network. . . . From an article in the July 1992 issue of *Sailing* magazine that focused on the America's Cup victory and other sailing achievements of Bill Koch, I bring you the following quote referring to Bill's graduating class: "MIT class of '62—apparently another academic vintage year at the famous Massachusetts brain farm." I guess we have aged well in bottle or cask! Speaking of wine and related concerns: **Dave Stare** was interviewed on CNN as an expert on the insect infestation that is threatening the grape industry in California. While it was a pleasure seeing Dave on TV, it is a shame that the wine makers in California are having such problems.

Class Treasurer **Tony Mack** sent me a newsclipping from the *Wall Street Journal* announcing that classmate

William Bloebaum

William D. Bloebaum has been named president of Mead Pulp Sales, Inc., a subsidiary of the Mead Corp. of Dayton, Ohio. Bill joined Mead's electronic publishing subsidiary, Mead Data Central, Inc., in 1984 and was elected corporate treasurer and an officer of Mead in 1988. Before joining Mead, Bill worked with Accu-Ray Corp., Chevron Chemical, and The Cosmodyne Corp. in sales and sales management.

John A. Rollwagon, chair and CEO of Cray Research Inc. in Eagan, Minn., has been appointed to the board of directors of the St. Paul Companies of St. Paul, Minn. This is an indication that supercomputers mesh well with the insurance business. . . . **Bruce G. Brown** writes that he is currently professor of medicine/cardiology at the University of Washington School of Medicine. Bruce is working on cholesterol lowering approaches to preventing heart disease. He is still using the analytical geometry taught by George Thomas in 18.01.

Barry J. Fidelman writes that he is alive and well after three years in the venture capital business with Atlas Venture, an international firm with offices in Boston, Amsterdam, and Munich. Barry and Atlas are focusing on early stage information and health care companies in case anyone has some good ones to promote. . . . **Herb Selesnick** is still president of Sterling & Selesnick, Inc., an employment relations consulting firm headquartered in Salem, Mass. S&S provides dispute resolution research and training services to government and industry. Herb and his wife/partner, Hinda Sterling, reside in Beverly on the waterfront. They have three daughters, one granddaughter, and a partially housebroken Lhasa Apso.

If you have an e-mail capability and haven't done so, please subscribe to MIT1962, now operating through the courtesy of the MIT Computer Systems. You may join the network by sending the message text: SUB MIT1962 to LISTSERV@MITVMA.MIT.EDU on the Internet system. If you can't figure that out, just send a message to MIT1962@MITVMA.MIT.EDU or to HMCCARL@ENGSYS.ENG.UAB.EDU and we'll put you on the e-mail network. We would like all classmates with e-mail connections and the ability to communicate with Internet/Bitnet/Telnet, to sign up on the network. The Alumni Office will be requesting your e-mail addresses and setting up a master system for all classes, but we are pioneering the effort with our own network as a trial run for the rest of the alumnae/alumni.

As always, even if you don't use high tech communications, just send a note or card via the U.S. Postal Service to: **Hank McCarl**, secretary, P. O. Box 352, Birmingham, AL 35201-0352

63 30th Reunion

I am grateful this month to **Frank Levy** this month, and you should be too. He wrote me a long newsy letter, so I won't have to expound on politics and public policy. I will merely quote and paraphrase at length. Frank has returned to the Institute after 29 years, this time as Daniel Rose Professor in Urban Studies and Planning. After graduating with our class, he went on to receive a PhD in economics from Yale. Before completing the degree he got a teaching position at Berkeley, where he remained ten years. In the midst he met and married Kathy Swartz ('71). When she finished her PhD they moved together to the D.C. area, where they have remained—each working at local think tanks and universities. Kathy is now at the Harvard School of Public Health. Frank has developed an interest in questions of national living standards and income inequality. He has taken the role of Dr. Gloom against **Henry Nau** as Dr. Sunshine in a fairly public debate on this area. He writes, "In fact, neither of us [is] this extreme, but *USA Today* likes nice sharp distinctions. I am currently working on a book with Dick Murnane, an economist at the Harvard Education School, about education and skills in the labor force. Truth be told, I did not have a great time as an MIT undergraduate...I studied a lot, and when I didn't study I was worrying about why I wasn't studying. But I am looking forward to going back and teaching and getting involved in both the education of urban planners and in MIT's various manufacturing [!] activities."

Thanks, also, to **Allen Clark**, who writes from Longwood, Fla. He has recently been promoted to director of R&D at Coca-Cola Foods. This division makes all the non-carbonated stuff, e.g., frozen orange juice. He has been chair for two years of the Florida Audubon Society—an environmental organization of some 35,000 members in 50 chapters.

Now, the press releases. First a comment: if you want a good long mention, write me a letter. **Ralph Grabowski** is now VP of Cambridge [Mass.] Scientific, a firm researching ways to turn waste material economically into a substitute for highway rock salt. Ralph had been, and may still be, a consultant on marketing new high-tech products. . . . **David Stickler** has joined Aerodyne Research in Billerica, Mass., as executive VP. He will lead a group investigating combustion and energy technology. Formerly David was Chief Scientist in energy technology at Textron Defense Systems. . . . Finally, **Barry Weissman** is now senior VP at Pall Corp. of East Hills, N.Y. He used to be a research leader at AT&T in Princeton.

Folks, it's the winter. Unless you are in California worrying about the next big quake, you have time on your hands now while staring out at the snow. So, you all write now, ya hear?—**Phil Marcus**, secretary, 3410 Orange Grove Ct., Ellicott City, MD 21043, (410) 750-0184, CompuServe: 72047,333; Internet: 72047.333@compuserve.com.

64

Greetings of the new year. May 1993 be happy, healthy, and prosperous for each of you. At some point last year, the average age of the class rolled

through 50. No such statistical milestones this year—but we are getting closer to our next reunion. Mark your long-term calendars accordingly and also volunteer to help with the arrangements if you can.

I received a brief note from **Doug Tuggle** informing me that he was recently elected VP-Member Services for The Institute of Management Sciences (TIMS). TIMS is an international society of management scientists, operations researchers, applied mathematicians, and information technologists. Doug is dean and professor of management at the Kogod College of Business Administration, American University, in Washington, D.C.

An Alumni/ae Fund note from **James Lerner** describes his work serving the people of California with the California Air Resources Board (CARB) Office of Strategic Planning, specializing in energy and air quality "linkage." An example of his recent efforts is participating in the Public Utilities Commission investigation of the role of California's regulated electric and gas utilities in commercialization of electric vehicles and natural gas vehicles. Current CARB regulations require 2 percent of all new cars sold in California starting in 1998 to be zero-emission vehicles. . . . A note from **Joe Boling** announced that he retired from the Army at the end of August and will be staying in Germany for a year or so. Then he plans to return to Seattle to pursue his interests as a free-lance writer, specializing in Japanese monetary history.

Two notes came in from Paris. **Sam Taub** is still enjoying life as an American in Paris with wife Gaby. Son Josh will be graduating from Brown this year as an economics major. Daughter Sara will receive her French bacalauriat and is looking forward to college studies, where she will specialize in medicine or law. . . . **Dave Slosberg** is also living in Paris, where he is running his own computer consulting company, importing cars from the U.S. for sale in France, and importing items for tourists into Senegal. His sons are both out of school now; one is a banker in New York City and the other is a lawyer in Palo Alto, Calif. The Slosberg family phone bill must be something to see!

A press release from the University of Virginia announced that **Bill Roberts** has been named a Commonwealth Professor in recognition of his eminent scholarship. He is professor of applied mathematics in UVa's School of Engineering and Applied Science. Bill is also director of the Mathematical-Computational Modeling Laboratory, where his work focuses on developing the mathematical equations that express events observed in nature and in the laboratory. For example, he has developed algorithms to study the structure and dynamics of galaxies. Bill received a PhD in applied math from the Institute in 1969 and then joined the UVa faculty. He and wife Linda have two children, Will and David.

Our final item comes courtesy of the Northwest Airlines seat selection algorithm that put me alongside **George Schmidt** on a flight from Boston to Washington. Though George and I hadn't known each other previously, his brass rat served as a terrific conversation starter. George is manager of the Guidance & Navigation Division at Draper Laboratory in Cambridge. He earned an SB, SM, and ScD in Course XVI and then joined the full-time staff of the Instrumentation Lab, which was renamed Draper Lab after divestiture from the Institute. George and his family are living in Lexington, Mass.; one son is at Boston College and one is close to graduating from Lexington High. George is enjoying the opportunity to attend real Division I college football games as a BC parent.

It's time for me to call my travel agent to make some reservations for a few more business trips. To those of you I won't meet in my travels, please send some news.—**Joe Kasper**, secretary, RR 2, Box 4, Norwich, VT 05055

65

I am pleased to report that **Ron Newbower** and his wife, Donna, joined Marie and me for dinner in September to celebrate the 30th anniversary of our meeting our spouses. Ron and I met Donna and Marie at the Simmons Freshman Mixer. Are there other classmates who met and married people from that mixer? . . . Ron and Donna just celebrated their 25th wedding anniversary with a small crowd of well-wishers. Their oldest is a senior in high school and beginning to think about college.

I seem to run into classmates in my business constantly. Recently I worked with **Peter Norris**, who just founded a new firm, NZ Applied Technology, after leaving Emcore where he had been VP of Process Technology. Peter had stayed at MIT to get a master's and doctorate and worked for RCA and GTE before joining Emcore. He is an expert in MOCVD technology. He lives in Cambridgeport, Mass., with his wife (sounds like he's lived there virtually since graduation!) and has one daughter about to graduate from Rutgers.

Another entrepreneurial classmate is **Dennis Slevin**, although Denny's work is primarily teaching. His recent paper in the *Entrepreneurship Theory and Practice Journal* won the award for the Best Paper of 1991 on the topic. He has developed a consulting practice around helping to audit "Total Competitiveness" and "Technology Transfer" for large companies. Denny's still happily married. His son, Jeff, 24, is at Tyndall Air Force Base after graduating from the Air Force Academy. His daughter, Kate, 15, has been involved in the regional olympic development soccer teams.

John Howard just moved back to Boston after 10 years in Pittsburgh working on the Andrew Project at Carnegie-Mellon. This was CMU's equivalent to MIT's Athena project. He recently joined the Mitsubishi Electric Research Laboratory where he focuses on distributed systems. When we spoke, his wife was still in Pittsburgh and they were trying to finalize where they planned to live. His children are both in college—one at Holy Cross and the other at the University of Pittsburgh. He reports that he immediately rejoined the Sailing Association and they remembered him after 25 years!

One advantage of being class secretary is that you occasionally get to re-establish old ties. Recently I called **Nick Stepaniuk** out of the blue and spent some time regaining lost ground. Nick had held a special fascination for me since his foreign influence meant he played the best volleyball around (meaning he played soccer). Nick lives in St. Louis, Mo., and still plays soccer regularly. His father had emigrated from the Ukraine and he married a woman from the Ukraine. Since graduation he has been with Mallinckrodt, where he focuses on chemical process develpment and engineering. He has one daughter, age 14.

Kirby Smith received a Technical Achievement Award from Lockheed Sanders' Countermeasures Division, which generated a discussion on his work. Although most of it is classified, he works in applications of electro-optics to countermeasures. During non-working hours, he is building an addition and doing major landscaping to his home in Derry, N.H.—when we spoke he was digging a lily pond. He married late and has one daughter, Kari, age 7.

Beacon Venture Management is really in the "management" business now. I am currently acting as president for two of our start-ups, Environmental Quality Corp. (waste minimization engineering and products) and Gel Sciences, Inc. (phase transition get technology), and hopefully you will see these mentioned in the future, although they are simply adjuncts to my primary position at Beacon.—**George McKinney**, secretary, 33 Old Orchard Rd., Chestnut Hill, MA 02167, (617) 890-5771

66

The Bronze Beaver Award, the highest honor the Alumni/ae Association can bestow, was presented to our own **Paul Rudovsky** at the Alumni/ae Leadership Conference last fall. Paul has enthusiastically served MIT in a variety of positions: class secretary, class vice-president, 25th reunion gift chairman (a record gift), member of the Association board of directors and its Audit and Budget Committee, and director of the New York Club. He has also created and funded a named scholarship fund.

I ran into one other classmate at the conference, **Bert Forbes**. He owns Ziatech, a California-based company that makes industrial strength micro computers. He says he has an ideal marriage—wife, Candace, has an MBA to complement his engineering degree so they run the company together. They have a son Bryn (15) and daughter Skye (11). Bert thinks his daughter has a natural bent toward engineering and he is already trying to steer her to MIT.

Donald York, director of the Apache Point Observatory, has been named Horace B. Horton Professor in Astronomy and Astrophysics at the University of Chicago. He is an expert on the clouds of dust and gas that exist between stars and between galaxies.—**Eleanore Klepser**, secretary, 84 Northledge Dr., Snyder, NY 14226

67

Our 25th Reunion was the most enjoyable to date. It was attended by about 140 classmates, many of whom traveled a great distance to attend. We are

indebted to the numerous classmates, spouses, and friends of '67 who helped make it a big success—too many people to name in this column. However, I would like to arbitrarily thank a few people by name. **John Rudy** put in countless hours to help make the reunion a success. General **Bob Ferrara** orchestrated the successful military operations on Saturday. In the words of John Rudy: "On Saturday we participated in the Alumni Games, where we competed against the other reunion classes in games of skill and knowledge. Using the same degree of preparedness and ethics that characterized our two Field Day wins, we proceeded, under the direction of Bob Ferrara, to trounce the other classes. Since we had made up special buttons for the winners, it was particularly important that they not go to someone else." I believe our biggest "THANK YOU" must go to **Lutz Henckels** who published our incredible Reunion Book. (Whether or not you attended the Reunion, you should have received a copy; if you haven't, please contact me.) The book is simply the most outstanding Reunion Book ever at MIT. It includes not only the traditional biographies of class members, but it also contains numerous fascinating retrospectives from a number of our classmates. It's wonderful, high-quality, entertaining addition to your library.

Gary Garmon and **Jeff Wiesen** successfully co-chaired our $1.7 million Reunion Gift campaign; we also thank the individual classmate who contributed the lion's share of the total. Bob Ferrara notes that **Mike Zuteck** has produced a very entertaining videotape of some of the events of our reunion, such as Jeff Wiesen's excellent speech on Friday and our post-party party in Baker House Saturday night. Regarding Bob's report that there's a movement to draft Mike as our official class videotaper for future reunions. . . . DONE! Congratulations Mike!

Roy Gamse has been named senior VP of marketing for the consumer market segment at MCI Communications Corp. in Arlington, Va. . . . **Isom Herron** is now a professor of mathematical sciences at RPI in Troy, N.Y. . . . **Holliday Heine** has received a law degree from Suffolk University. She and her husband, John, have two children and live in Weston, Mass. She is a patent agent for Weingarten, Schurgin, Gagnebin & Hayes in Boston.—Sharlotte and **Jim Swanson**, co-secretaries, 878 Hoffman Terrace, Los Altos, CA 94024

68 25th Reunion

We have just returned from Cambridge where we attended a planning meeting for our fabulous 25th Reunion. Under our class president, **Rick Lufkin**, plans are going well. I won't give details here since they may change by the time this is printed. **Mark your calendar for June 3-6, 1993!**

If you can get to Boston the previous week, you will have an opportunity to march in the commencement procession. Until last year only the 50th Reunion class did so, but now both the 25th and 50th are invited. The 50th class wears red class jackets while the 25th class wears gray ones. (If you consider yourself a class member and don't get an announcement in the mail it may be because the computer assigned you to the year you got your first MIT degree. People are more important than computers so write us and we'll straighten out the problem for you.)

Class gift planning is also proceeding well under **Steve Finn**. Stay tuned also for news about the exciting class book where you'll have an opportunity to write something for posterity about yourself.

While we were visiting MIT it was announced that **Bob Metcalfe** was awarded the Henry B. Kane '24 Award in recognition of exceptional service and accomplishments in fundraising for MIT. Bob is now publisher/CEO of *InfoWorld*, based in San Mateo, Calif. . . . From out west we hear that **Don Baker** is "still plugging away" at a PhD in soil physics/groundwater modeling at Colorado State and is looking for employment. . . . **Neil Cohen** is writing a computer program to play bridge.

That's all we have for this month. We're looking forward to seeing you in June. Feel free to drop us a line soon now that we're back from Japan and settled.—**Gail** and **Mike Marcus**, secretaries, 8026 Cypress Grove Lane, Cabin John, MD 20818

69

At least one of us has retired! Dr. **John R. Smith** writes, "I'm now in my third year of retirement and enjoying it immensely. Primary activities are tennis, golf, home improvements (just completed a solid marble master bath), traveling, and scouting out the ultimate set of retirement locales. In July, my wife of eight years, Dr. Vivien Dee, was named a fellow of the American Academy of Nursing. She is currently director of nursing and associate hospital administrator at UCLA."

During the Alumni/ae Leadership Conference on September 19, **Larry Birenbaum** received the Henry B. Kane '24 Award. The award is given in recognition of exceptional service and accomplishments in fundraising for the Association and/or the Institute.

My friend Arthur C. Clarke alerted me he was going to do it. In "The Hammer of God," his fictional account of the future of the world in the "Beyond the Year 2000" special issue of *Time* magazine, in October, he wrote, "Meanwhile the Muslim world had lost much of its economic power when the Cold Fusion breakthrough, after the fiasco of its premature announcement, had brought the Oil Age to a sudden end." Think about it.—**Eugene F. Mallove**, secretary, 171 Woodhill-Hooksett Rd., Bow, NH 03304

70

There is little news this month. All we have is a sad report that **Bob Akullian** was killed last July. Bob was riding his bicycle when an unidentified driver ran a red light and crashed into him. At the time of his death, he was working for FXD Telerate in Mountain View, Calif. He is survived by his wife, Mary, daughter, Jennifer, and son, Mical. Our condolences to them all.

Please send us happier news for future issues.—**Greg** and **Karen Arenson**, secretaries, 125 W. 76th St., Apt. 2A, New York, NY 10023

71

Gerald Berstell is advising entrepreneurs in Bulgaria. If other MIT alumni/ae are interested in this program, they should contact the Citizens Democracy Corps at 1-800-394-1945. Gerald's assignment was to reverse the decline of a privately owned network of 11 Bulgarian business schools that had been started after the overthrow of communism. He began by conducting Bulgaria's first focus groups in order to understand the situations and problems of Bulgarian managers. His assignment concluded with a plan for a joint U.S.-Bulgarian development of case studies to apply Western business concepts to current Bulgarian management problems.

George Providakes

George F. Providakes has been named associate technical director in D050, Communications. He will lead MITRE's work in support of the Communications and Air Space Management Systems Program Office. He has an extensive background in advance satellite communications technology and systems engineering, gained on the Milstar program, as well as hands-on experience as a communications officer with the U.S. Army. In addition to receiving his Corps 6 degree from MIT, he received a doctorate in electrical engineering from Cornell University.

Gerald M. Rubin has been named a Fellow of the American Academy of Arts and Sciences in the cellular and development biology area. The Academy was founded in 1780 by John Adams and other leaders of our republic who charted the society to "cultivate every art and science that may tend to advance the interest, honor, dignity, and happiness of the free, independent, and virtuous people." For over two centures, the Fellows of the Academy have pursued this purpose by gathering together the country's leading figures from universities, government, business, and creative arts to exchange ideas and to promote knowledge for the public interest.

Please send your notes to **R. Hal Moorman**, secretary, P.O. Box 1808, Brenham, TX 77834-1808

72

Please send news for this column to: **Wendy Elaine Erb**, co-secretary, 6001 Pelican Bay Blvd., Apt. 1003, Naples, FL 33963; or **Dick Fletcher**, co-secretary, 135 West St., Braintree, MA 02184

73 20th Reunion

Venture capitalist **Vincent Tobkin** has joined Bain & Co. as a VP and director. Most recently he had been general partner of all four Sierra Ventures funds, which focused on early stage investing in computer-related businesses, services, communications, semiconductors, and advanced materials. At Bain, he will be supporting strategy consulting efforts for major corporate clients.

Vincent Tobkin

The first student has been named to the Class of '73 Scholarship. He is Eric Tavzel of the Class of 1993, a Course XIV from Annapolis, Md. Eric is a varsity football team player, a Sigma Phi Epsilon, and is active with various Institute committees and associations.

Lewis Held is the proud author of *Models for Embryonic Periodicity*. This first fruit of his fertile mind explores the several hypotheses and models for periodic patterns in living beings, such as the stripes on zebras. It is available through Karger Publishers in Farmington, Conn. Lewis comments that the book is the culmination of a 20-year thought process starting with a class on AI under Seymour Papert.

All is well here on the home front. Looking forward to getting up there for the 20th (gulp!) Reunion in the springtime and meeting old friends. Write!—**Robert M.O. Sutton, Sr.**, secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

74

Classmates, my pleas ("please?") have been answered! A white knight has come galloping into the village to share class secretary duties with your faithful scribe. His *nom de plume* is Sir **David Withee**, known to his friends throughout all Camelot as Dave. His first column will appear in this space next time so y'all be sure to tune in and read it. Send in notes about yourselves too, so Dave will have plenty to write about and not get scared away.

It's a short column this month. Hope your wal-

lets were longer than your holiday shopping lists. . . . A fine long newspaper article from NASA's Langley Research Center tells us that **Woodrow Whitlow** was awarded a NASA Exceptional Service Medal in June. Woodrow is head of the Unsteady Aerodynamics Branch of NASA's Structural Dynamics Division. . . . **Vincent Tobkin** has "returned to the world of management consulting" as a partner and director of Bain and Co. in San Francisco. Christine and Vincent also had their third child, rounding out the family with Gregory, Carolyn, and little Alexander. While their primary residence remains in San Francisco, the family is enjoying weekend stays at their new retreat in St. Helena in the Napa Valley. Vincent says he is "working hard to familiarize myself with more wineries."

I told you it was short. Happy New Year.—Co-secretaries: **Lionel Goulet**, 115 Albemarle Rd., Waltham, MA 02154-8133; **David Withee**, 1202 Linden Dr., Mt. Pleasant, IA 52641

75

Happy New Year! Here's the news: **John Dana Chisholm** received the Harold E. Lobdell '17 Distinguished Service Award, and **S. William Wang** received the Henry B. Kane '24 Award. Awards were announced during the Alumni/ae Leadership Conference on September 19, 1992. The Lobdell Award is given in recognition of valuable alumni relations service to the Association and/or the Institute. Congratulations to you both.

I received the following from **James Demers**, "I finally bit the bullet and got married this past May, to Mary Morry. Mary is—unmistakably—a product of Brooklyn. A graduate of St. Joseph's College, she obtained a PhD in molecular biology and also a JD from Columbia University. She is now a patent attorney at Morgan & Finnegan, somehow having evaded Pennie & Edmonds' net.

"Present at the wedding was classmate **Richard McCarthy**, and David Gifford ('76), both of whom became fonts of information on the pleasures and perils of married life. Both are doing well. We had a small wedding, and I offer my apologies to the many MIT people who weren't invited.

"I recently was shocked by sudden arrival of my 10th anniversary as an employee of Johnson & Johnson. Time does seem to fly, so I must be having fun here. Mary and I remain in Manhattan, just a few blocks from Columbia, so any MacGregor Turkeys who pass through the Big Apple should look us up. . . we're in the book!"

And finally, I received a note from **Steven A. Simoni** letting us know he is still fishing as much as possible. The note included a clipping from the July 10, 1992, *Norwood Daily Transcript*, showing a picture of Steve hoisting a beautiful 20 lb., 8 oz. striped bass by its gill. He caught it at Lake Texoma on the Texas/Oklahoma border. He also got to see a vacation home of Ross Perot located on the lake. (No doubt the fish meant more to Steve). That's all for now.

Keep writing.—**Jennifer Gordon**, secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036; or 18 Montgomery Place, Brooklyn, NY 11215

76

Mail, and other communications media, have been very scanty. Please write, call, fax, or modem. We really do need your collective support in order to ensure having a column in each issue. No news, no column!

Ter More is the "president of Transwest Geochem, Inc., providing mobile analytical services to environmental industry. Wife, Tracy, had twins on May 17, 1992: Shelby Hazen, and Madeline Francis." . . . **David Modest** has received the 1992 UC Berkeley Distinguished Teaching award, the campus' highest teaching honor. David previously had received the Haas School's Chief Teaching Award for 1990–91. David is an associate professor of economics and chairs the MBA finance group. David's research has revolved around empirical tests of asset pricing models, global portfolio management, and futures and options markets. (Naturally, these are also topics that remain near and dear to your secretary's heart and checkbook.)

On the topic of futures and options, we have news from **Mike Sarfatti**, who left engineering to move into this area as well. Mike is the VP of Fractal Markets, Inc., 2127 Hyde St., San Francisco, CA 94109, tele. (415) 885-2293. They have been getting great press for their forecasts in the local San Francisco press. They are using prediction methods derived out of chaos theory to forecast market moves and magnitudes in certain futures-related markets such as bonds and stock indices. Based on your secretary's extremely extensive knowledge of the entire field, I believe it will be only a matter of time before they become nationally, and even internationally, renown money managers. Currently, according to Mike, they are talking with only institutional customers, such as various State government pension authorities. Your secretary's advice, to any of you who can provide institutional business to these people, is to indeed try them before they become too big and/or famous. Based on my experience, later on they will not be as approachable.

As for your secretary, the bond market continues to provide me with thrills and chills while trading for my own account. Likewise, the broad superhighway (and my favorite) of trading: foreign exchange. As I write these notes in late September, it is increasingly clear that the markets are indifferent as to who is sitting in the White House. Either candidate is going to have to make some unpopular choices to the masses, which are acceptable to

the financial markets.

Otherwise, my efforts in the computer and telecommunications business are starting to blossom. Among the business I hope to have booked by the time these Notes are printed is an international e-mail system design and installation, with an interesting twist. Some of the nodes are in countries where the government owns the phone company, and as a result, international rates are much higher to send to the United States, than the rates to send *from* the United States. With the aid of some technology, we are going to arrange for the cost to be shifted to the lower tarriff venue, thereby becoming very popular with our client, and I hope, not antagonizing the government concerned. This type of business is like futures trading, with a technology twist.

Please write, fax or call. We need your news.—**Arthur J. Carp**, secretary, Quantalytics, Inc., 220 Henley Rd., Woodmere, NY 11598-2523, (516) 295-3632, fax: (516) 295-3230

77

First, a word from our president, **Carol C. Martin**. "The final numbers are in for the 15th Reunion Gift—we raised a record-breaking $112,446! Thanks to Brian Hughes, the Count UMOC challenge was a great success in encouraging an impressive number of upgraded gifts. We also surpassed our goal with a total of $167,400 in the Class of '77 Student Aid Fund. As Reunion Gift chair, I would like to congratulate the Gift Committee on a job well done, and I would like to thank everyone who contributed to a very successful Reunion Gift."

Carol and her husband, Tom ('76), were among the class members to enjoy the reunion festivities in June. On the assumption that you will agree that old news is better than no news, I'll fill you in on what I learned during the reunion. If I've overlooked anyone who wanted to see his/her name in print, please send nasty letters to the address at the end of this column! . . . Most of my news gathering and socializing were conducted at the Reunion Party at the Pierce Boathouse. We were joined by MIT sophomore Charlotte Iverson, '95, our student ambassador, who reminded us all of how young we once looked. MIT was also represented by a kind and helpful Boathouse staff member named Warren, who generously volunteered to take all of the extra food from the evening to a homeless shelter in Cambridge.

As far as I could tell, the alumnus who traveled the farthest to be with us was **Ramiro Garron**, who joined us from Germany. Ramiro is now living in Wiesbaden working for an American company. . . . **Michael Herrera**, who used to live in Europe, is now living in Rhode Island. Michael has finally been able to combine his interest in languages and his training and interest in computers and technology in his new position revamping and automating his father's technical translation business. Sounds like the perfect job for him!. . . . **Eric Black**, who so competently ran our class elections, also has been traveling. "One week before leaving for the Soviet Disunion (Russia nad Ukraine), I left my job of five and a half years as the principle architect of Atherton Technology, the creators of the first commercial integrated project support environment. I am now consulting in the areas of software engineering environments and object-oriented databases. The tour to Russia was as the Russian-speaking square and contradance caller with a group of dancers and musicians. If you're a dancer and are visiting the San Francisco area, come to one of our dances!"

Leo Harten, who lives on Putnam Street in Cambridge, believes that he came the shortest distance to the reunion. (Last reunion, you no doubt remember, Leo was the classmate who came the farthest!) Three years ago Leo married Marie Donnelly. She was the secretary to his master's thesis reader at MIT. They are the proud parents of two cats. Leo reports that he is releasing PARAMAX software (based on the MIT MACSYMA computer algebra system) for VAXes and sons. Leo reports that in the 1,000 square feet of living space in his apartment he has an Internet connection, a VAX, and two sons. His e-mail address is LPH@paradigm.com. . . . Another Massachusetts resident is **Kevin Miller**. Kevin wears many hats, currently medical director of the Center for Psychiatry at Holyoke Hospital, chief of psychiatry at Holyoke Hospital, and president of the Western Mass. Psychiatric Society. He married Marla Mondschein, M.D., in 1990. She and their daughter, Rachel, enjoyed the reunion with Kevin.

Steve Blotsky and his wife, Pam, joined us from Nashua, N.H. Steve and Pam both work for DEC, he in computer security, and they have two sons, Jonathan, 2, and Benjamin, 6. . . . **Glenn Brownstein** is now with his fifth newspaper since graduation. Currently he is assistant sports editor at the *Courier Journal* in Louisville, Ky. He and wife Debbie (Lesley, '78), an educator at the Louisville Zoo, live across the Ohio River in Clarksville, Ind. Glenn, you may remember, is a former editor of *The Tech*, and perhaps more importantly, a former member of the sixth floor of Baker, otherwise known as the "hockey floor." Given his illustrious sports past, Glenn wants all his former floormates to know that his athletic prowess won him a hockey contest with the Louisville minor league hockey team. Glenn made 13 of 20 shots on goal to advance to the finals in an on-the-ice contest, where he blew away the other competitors to win season tickets as well as 500 gallons of gas!

I received a nice letter from **Jim Torma** expressing his regrets in missing the reunion. In May 1992 he finished medical in San Antonio, Tex., after having struggled through five years with 200 classmates who, on the average, were seven years younger than he and mostly unmarried and childless. Now Jim is in Youngstown, Ohio, with his wife and three children ages 4, 8, and 10. He is doing an anesthesiology residency for the Western Reserve Care System. He reports that even though it's a four-year program, already it feels infinitely better than being in medical school.

I will fill you in on more class news (reunion and otherwise) as the months go by. I wish you all a happy and successful 1993!—**Ninamarie Maragioglio**, secretary, 8459 Yellow Leaf Court, Springfield, VA 22153-2522

78 15th Reunion

We received news clippings about **John Little** who received the New England Software Entrepreneur of the Year award. John is president and co-founder of The Mathworks, Inc., which was established by John in 1984 and now has 100 employees. The firm created and markets MATLAB, a powerful mathematical program for system design, analysis, and modeling for engineering and general science. John lives in Sherborn, Mass., with his wife and two daughters. . . . **Matt Lieff** and wife Sue announced the arrival of Kara Pearl in September 1992. Congratulations to the Lieffs, who live in Cheltenham, Pa. . . . ABC Evening News featured the MIT football team in a somewhat tongue-in-cheek segment. It showed MIT's quarterback in an aero/astro class taught by Professor **Paul Lagace**.

Life for your class secretary and wife **Diane Curtis** in Newark, Ohio, is enjoyable, if not hectic with two babies, Danielle (19 months) and Luke (12 months). Diane has embarked on a real estate career that she is enjoying very much.—**Jim Bidigare**, secretary, 9095 North St. Rd., NW, Newark, OH 43055-9538, (614) 345-8582

79

Happy New Year! **Mark McPeak** writes from Quito, Ecuador, where he lives with his wife, Jean. Mark is regional director for PLAN International, which supports community development activities in poor communities in more than 20 countries, including Colombia, Ecuador, and Bolivia. Mark would enjoy hearing from alumni/ae living in South America. His address is Casilla 17-11-06374, Quito. . . . **Jim Atwood** writes, "My wife Kathy (Tufts, '80) and I have entered a frenzied stage of life with a new house (Concord, Mass.) and our firstborn (Samuel Henry, born December 6, 1991). I'm trying to grow a young vision systems company — Vista Systems in Peabody, Mass.—with partners Jay Nevin, '70, and Jose Valle, '78."

Your faithful secretary is once again rehearsing an Off-Off-Broadway musical. This time it's *Dames at Sea*, and I play the lead role of Ruby. Like the lead role I played last spring in *Oklahoma*, this is a part for which I was once turned down by the MIT Musical Theatre Guild. I feel like the woman in the haircolor commercial: "I'm not getting older, I'm getting better!" Til next time—**Sharon Lowenheim**, secretary, 98-30 67 Avenue, Apt. 6E, Forest Hills, NY 11374

80

Seanna (Friedman) Watson is still designing IC's with Northern Telecom in Ottawa, Ontario, Canada. She has two boys, ages 5 and 7.

Congratulations are in order for **Paul Rothman**. Paul, assistant professor of clinical medicine at Columbia University College of Physicians and Surgeons, has been named a 1992 Pfizer Scholar. The Pfizer Scholar Program for New Faculty award is intended to encourage and provide opportunities for developing the research potential of physicians during the years following completion of their clinical and research training. Paul's research has centered on studies investigating the molecular mechanisms that control immunoglobulin heavy chain class-switch recombination. He is also the recipient of the James S. McDonnell Foundation Career Development Award in Molecular Medicine and Oncology, and the American College of Rheumatology Senior Rheumatology Scholar Award.

Paul Rothman

Congratulations also to **Mark Vangel**, who received a PhD in statistics from Harvard University. Mark is employed at the United States Army Materials Technology Lab in Watertown, Mass. Send your news to: **Kim Zaugg**, secretary, 2384 Leslie Circle, Ann Arbor, MI 48105, (313) 665-2365, vayda@erim.org

81

It's been a little windy down here in south Florida since the last time I reported. Our thoughts go out to those of our classmates and acquaintances living in the areas devastated by Hurricane Andrew. By the time this goes to print, hopefully recovery efforts should be well advanced.

"Coolness!" **Michael Brower**, an energy-policy specialist, is research director for the Union of Concerned Scientists. He has written a book, published by the MIT Press, entitled *Cool Energy: Renewable Solutions to Environmental Problems*, in which he shows how, with the right policies, renewable energy could provide as much as half of America's energy needs within 40 years. Mike's book has been praised by many, including Senator Al Gore, Jr., who calls it "an invaluable resources."

Environmental matters II: Continuing the theme of environmental consciousness, **Clifton McFarland** let us know that he has joined the law firm of

Vorys, Sater, Seymour and Pease in Columbus, Ohio, and is practicing in the firm's environmental group. Clifton previously was a design engineer for Chevron Corp. and an associate in the hazardous waste engineering division of CH2M Hill Consulting Engineers. He then switched careers, attending Columbia University School of Law, from which he received a JD in 1988. Before his move to his present firm, Clifton practiced law at an environmental firm in Los Angeles.

Global marketing: **Stephen Peele** writes that for the past year or so he has been in a training program with GE Aircraft Engines that develops global marketing managers. This two-year program, comprising four six-month assignments, includes training in marketing skills, language, and cultural awareness. Stephen's particular area of expertise is the former Soviet Union. He has reached the point at which participants "go into the field," and is looking forward to a six-month assignment in that part of the world. Stephen also relates that he has considered pursuing a PhD, but has not as yet found the right opportunity. He was, however, accepted to the MIT Management of Technology program, but is still hoping for the necessary sponsorship (hard to come by in this period of corporate downsizing). Stephen also tells us that he now has two beautiful sons.

Home base: We are informed that **Stu Anderson** has set up his own shop, Anderson Engineering. According to Stu, "After a career moving into ever smaller companies with ever greater satisfaction, I have just hung out my shingle as an independent consultant operating in the comfort of my garage." Stu lives in San Diego with wife, Brenda McDonough, '83, and they are expecting a child as of November.

Hope your holidays are happy, and thanks to all who wrote in.—**Mike Gerardi**, secretary, 1515 S. Flagler Dr. #1204, West Palm Beach, FL 33401, (407) 655-5050 (w), (407) 835-9013 (h)

82

Greetings from California. I just returned from attending the Alumni Leadership Conference. It was great seeing other classmates. Attending from '82 were **Charlie Frankel**, **Mike Dominiak**, **Patrick Houghton**, **Lina Janavicius**, **Lucinda (Lucky) Linde**, and **Mindy Garber**. My apologies if I missed anybody. I took the opportunity to get more material for the class notes section. Here goes.

After the conference, Pat, Mike, and Lucky went to a cookout hosted by **Tom Popik** and his wife, Mary Catherine Car. Also at the party were Lucky's husband, Lew Marten, Duane Horton, '81, **Dave Andre** and his wife, Rebecca, and **Andreas Hoffmann,** his wife, Ann, and their big energetic one and a half year old son Christopher (chip off the old block).

Tom Popik has recently formed an information services company for financial institutions called Geo-Segment Systems. We are looking forward to seeing Tom on the Forbes 400 list in a few years. . . . Andreas Hoffmann is one of the founders of a new company, Gensym. . . . Dave Andre is the PC engineering development manager for Object Design Software. . . . Patrick Houghton, still in Palo Alto, Calif., recently married Anne Sauvageot, a Berkeley liberal arts graduate. After studying at Stanford, he spent six years at Trimble Navigation selling GPS receivers to the government and military. . . . Mike Dominaik is project manager on SAIC's FAA system upgrade. Mike has been at SAIC for over 10 years now, tying the record for our class. . . . Lina Janavicius was married to Lou Morales on October 24, 1992. . . . Lucinda Linde has changed jobs and is now an operations manager at Molten Metal Technology. In her spare time Lucinda sailboat races aboard *Locomotion* with her husband Lew.

Michelle Gabriel was married to Jon Barrilleaux on October 4, 1992. Michelle graduated from Berkeley with an MBA this year and is now working in production management. . . . **Patricia (Robinson) Boucher** is now working in a state-of-the-art packaging lab for Fujitsu.

I'm sure many of you have wondered what happened to **Charlie Frankel** our former class president. Charlie went to work as a systems engineer for AccuRay in Columbus, Ohio, after graduating in June 1983 (he took an extra year to finish his thesis). He then transferred to their Singapore office in 1984 where he stayed until the summer of 1988. During that time he worked throughout the Far East, mostly Indonesia, Taiwan, Hong Kong, and China. During his stint in Asia he moved into sales and marketing and was an educational counselor for MIT while in Singapore. Since he was so far away he was unable to attend our fifth year class reunion. He returned in 1988 to attend J.L. Kellogg Graduate School of Management at Northwestern University and received a master's of management in 1990. After grad school he went to work for The Boston Consulting Group in Chicago. He has recently left BCG to pursue yet-to-be defined other interests.Charlie participated in the Alumni Fund Visit program and helped raise funds for the 10th Reunion Gift. Remember all of those letters? Guess he is still trying to get a life. He is looking forward to seeing even MORE people at our 15th Reunion.

Speaking of gift giving. The results from the 10th year reunion gift are in. Our class raised $56,045 which puts us as the fifth highest 10th year reunion gift ever. Way to go! If we had raised just $846 more, we would have been the third highest class. Maybe we can make up for it at the 15th. There was an impressive 37 percent increase in the number of donors making gifts of $100 or more! I also found out at the Alumni Leadership Conference that the Alumni Fund donation limit is being raised from $50,000 to $100,000 per year. I know that I sure feel better about that. How about you?

For those of you who are interested, there is a great photo of all of us who attended the brunch at Endicott House. If you would like a 5x7 copy please send $2 (and information for the class notes) to **Mike Colucci** at 5617 South Chapel Dr., Saginaw, MI 48603-2806.

More news: After graduating from MIT, **John Loeber** returned to Germany and picked up the old-fashioned law degree. He finished last month. It takes 10 years in Germany which includes three years of state-run legal training. He is in the process of finishing his doctorate on East German international civil action law, which turned out to be quite advanced by international standards. He plans to get a job in a large American electronics company. He married Gerburg Jung last year and they are expecting their first child in a couple of months. He would like to hear from some old MIT friends, specifically, **Michael Colvin**, **Dennis Clougherty**, **Zach Robinson**, **Fred Barrett**, **Theodore Stefanik**, and **Paul Bui**. Write him at Gehlenkamp 14, 2 Hamburg 56, Germany.

That's all for now. Keep those cards and letters coming.—**Helen Fray Fanucci**, secretary, 502 Valley Forge Way, Campbell, CA 95008, internet 74005.744@compuserve.com

83 10th Reunion

At September's Alumni Leadership Conference, **Sarah Bingman, John DeRubeis, Ivan Fong, Eric Gold**, and **Hyun-A-Park** held a summit meeting to discuss our 10th reunion activities. Some of the suggested ideas were: a picnic on a farm; a party with the 5th, 10th, and 15th reunions; an entrepreneurship workshop; and a review of emerging technologies over the last 10 years and how they have changed since our time at the 'Tute.

Sarah is our reunion activities chair and works for a high-tech firm north of New York City. John is the co-chair, along with **Guiermo Chang**, of our reunion gift effort, and works for IBM in their consulting division. Ivan is a lawyer in Washington, D.C., for Covington and Berling. Ivan will coordinate our class survey effort. Eric is teaching math at a prep school in Maine and has lots of enthusiasm and ideas for a great reunion. Hyun-A, our class president, is working for an architecture and planning firm in Boston, specializing in work on the Central Artery, otherwise known locally as the "Big Dig."

Aline (Jones) McKenzie did something that few of you do anymore—wrote a letter! A few years ago, Aline decided that watching science was more fun than doing it herself, so she left graduate school (neuroscience at UCSF) and turned to journalism. A few months ago, Aline began a new job at the *Dallas Morning News*, covering the super conducting supercollider. Aline writes that she would love to hear from other MIT graduates in the Dallas area, especially ones with story tips.

We received a press release noting that **Katharine Alexandra Marvin** has been awarded the degrees of jurist doctor and master of studies in law by Vermont Law School in South Royalton, Vt.

And please feel free to embellish the truth—we're always looking for a good story.—**Jonathan Goldstein**, secretary, c/o TA Associates, 45 Milk St., Boston, MA 02109

84

I am sorry to report the death of our classmate **Steven McClung** this past July. Steven was a software engineer at Lincoln Labs. Please contact me if you would like information about memorial contributions.

Stephen McDonald works for the Earth and Planetary Sciences Department at MIT. He recently attended an APO alumni meeting in Boston this past summer, which was in preparation for the APO National Convention held in December. Stephen's wife successfully executed a surprise 30th birthday party for him. His family came up, and he was distracted by being enlisted to help move Greg McMullan, '85, from Wakefield to Allston. Co-conspirators included Ellen Kranzer, '83, and Laura Daly, '86. The party was successfully launched from the kitchen where a surprised Stephen was caught on videotape.

Well, it may seem early, but we want to start forming our 10th Reunion committee. Here is what we are looking for. The chair should be someone local to the area. We would like some local volunteers to help with the logistics of setting up the events. We want everyone's ideas for events and a class gift. We also need a gift chair. We would like some regional reunion committee members who can help rally attendance from their areas. If you are interested in volunteering in any capacity, or have ideas for events you want to attend, please get in touch with me soon.—**Howard Reubenstein**, secretary, 28 Mitchell Grant Way, Bedford, MA 01730, (617) 275-0213, hbr@mitre.org.

85

Hi, it's me again, filling in for Bill! I got e-mail from him yesterday, so he is back from his travels. Unfortunately, the mailbox has been empty for two months now! So, stop holding back everyone and drop Bill a note.

Mike Candan flew to Hawaii in June to see the wedding of Stephanie Taddy, '88, and Keiji Oshita. He was the "boy next door" while she was studying in Japan in the MIT STS Program. They held the wedding at an oceanfront home on the island of Oahu. The place looked like a scene right out of *Magnum*. **Matt Giamporcaro**, Toby Sanders, '90, Michael Mann, '89, Alan Manuel, '89, and Sharon Weber, '88, all came out for the wedding. In August he flew out to California for **Dave Lyon**'s wedding to Carla Everett. They held the wedding and reception in Los Gatos in the community center of the development they live in. The wedding took place on a hillside overlooking Monterey Bay. Matt showed up for this wedding too (he shares a house with Dave) along with Stephanie and Keiji, and as a bonus Mike got to see Zahid Ansari, '84, and his new bride.

Kathy Balles writes that **Kris Dinsmore** married Dave Whitney in June of '91. Kris left Analog Devices for Allegro, a company in Worcester, Mass. . . . **Alysa-Ann Kodisch** visited recently from Switzerland where she lives in Basel with her beau, Thomas Sutter. Alysa will be completing a master's degree soon and has gotten a job with a Japanese company in Switzerland. Kathy and her husband Eric, '80, visited **Chris Woelfel** in Seattle, Wash, where she has settled (probably temporarily knowing Chris) in a break from her world travels. Chris has one quadrant of the globe left to explore (South America), but for now she is employed as a water quality engineer for the city of Seattle. Kathy is staying home taking care of her two boys, ages 1 and 3, and her 1.5-year-old niece. She says her home is on a par with Homestead, Fla. (last September), but it's worth it!

Michael Bernard writes that he enjoyed months of relative relaxation (40-hour work week!) since the last proposal at TRW, sitting around and waiting to actually win one of those proposals and have to work it. Well, his luck ran out, and they did indeed win the FEWS program. That means they will have to work it for the amount TRW bid, which translates into large unpaid hours of overtime. In August he got pulled off FEWS to work another front-end study that apparently is extremely important to the future livelihood of TRW's space business. He just loves stability! He needs a cellular phone due to the office changes; his real phone never keeps up. Actually, he needs a cellular desk, chair, bookcase, and computer for that matter Michael is now working on the FEWS Program again and is staff to the deputy program manager, responsible for strategic planning, white papers (studies), briefings, etc. He just bought his first tree for the office. He is the proud owner of a bamboo palm and is thinking of naming it Monty.

Michael had lots of fun at the Hollywood Bowl last summer. He managed to bump into **Tony** and **Linda (Wormley) Falcone** there. Julia Hsieh, '89, and he went camping with some friends up in Big Sur. The estimated wedding date for Julia and Michael is sometime in the first half of '94. That is carefully calculated to coincide with their friends' increased salary and therefore increased wedding gift potential. Unfortunately, the equation does not take into account home mortgages, babies, geologic movement of the continent, etc. They are thinking of doing a Quicktime wedding announcement for invitees with Macs. Too cute.

I have been really busy this past month putting together the class newsletter, which you all should have received by now. So, I'm reminding you that if you are interested in volunteering for any of the committees, stop procrastinating and give the organizer a call—please! Also, be sure to return the questionnaire. I'm really psyched to get started on some marvy artwork/merchandise for the reunion and beyond, but I need some help!—**Stephanie Winner,** administrative secretary filling in for **Bill Messner,** 8 West Winkley St., Amesbury, MA 01913, (508) 388-3872, messner@cmlds6.berkeley.edu

86

Got two letters this month. Thanks for the news. PLEASE WRITE!

Rich Maurer took a trip to the Orient. He flew a couple of missions out of Japan, Singapore, Alaska, and Hawaii. Singapore was really cool. I'll get a chance to see Rich at **Karl Tucker**'s wedding on October 24 in Boston. More to come on this later. . . . **Grace Saccardo** dropped a line to tell everyone she's getting married. Congratulations! The lucky guy is Mike Judy, '87, and the big day is September 5, Wrentham, Mass. Grace has worked at Hewlett-Packard in Cupertino, Calif., for five years, and this past year she spent at Stanford Univ., where she pursued a master's in computer science on an HP fellowship. Mike is attending Berkeley for a PhD in EE. More to come on this later, too.

I regret to inform the class that **Paul Ramos** was killed in a car accident during Memorial Weekend. He is survived by his wife and 3-year-old daughter.

Jeff Arenberg graduated from Berkeley in May 1991 with an MBA. Since then, he's been working as an assistant controller at Cypress Semiconductor in San Jose, Calif. In June 1992, he traveled to Chicago to compete at the U.S. Fencing Association National Championships in épée. He finished the season in 13th place in the U.S. While in Chicago, he saw **Ellen Dixon** and **Keith Law** along with their 6-month-old son, Travis. Ellen is starting a new job with a law firm in Chicago, and Keith's starting a PhD program at Northwestern.

Noel Zamot is flying his *@#?& off. He married Diane Provost of Panama City, Fla., on May 30. They had a wonderful honeymoon in Banff, Canada. . . . **Marily Oberhardt** attended the wedding (even though Noel stood her up at the airport!) . . . **Anthony Kolb** spent Christmas 1991 with **Eric Levine** on a sandy cliff overlooking an idyllic island bay in South Thailand, bringing back memories of similarly happy times overlooking "those dirty waters" from the TDC roof. Eric celebrated his recent completion of a Princeton psychology PhD by showing off his newly perfected mind reading skills to village children. Several months later, Anthony celebrated a promotion at UNEP with the arrival of a 9-pound, 4-ounce kicking and screaming Amerasian boy, Khamrone Alexander. Anthony is planning to return to Wisconsin in January 1993 for grad school.

Please write! **Mary C. Engebreth**, secretary, 1805 Manhattan Ave., Hermosa Beach, CA 90254, (310) 376-8094

87

The *Chatham* (N.Y.) *Courier* reports that **Terry Simkins** received a master of music degree (with distinction) from Princeton University this past spring. No word on Terry's future plans. . . . **Jennifer Hyman** is living in San Francisco, Calif., and works for an environmental consulting firm in Oakland. In her spare time, she sings for a band called Good Grief. (Lots of musical talent in the Class of '87... Remember Cool Moon? I recently saw that their band's logo is still hanging in the window of the Sigma Phi Epsilon house on Beacon Street.) . . . Navy Lieutenant **Edward Cashman** is currently participating in Tandem Thrust, a major maritime exercise aboard the guided missile cruiser U.S.S. *Arkansas*, homeported in Alameda, Calif. Edward is one of 20,000 military personnel taking part in the exercises, which employ approximately 19 ships and subs as well as 200 aircraft.

Chuck Davis reports from his home in Tuscaloosa, Ala.: "I got married on June 20 in Mobile. My wife, Jan, is from there, and I've known her for about seven years. **Jim Haggerty** and **Mark Miller** both came down from Boston, and **Andy Sterbenz** came from Fort Stewart, Ga. Derek Rutherford, '90 (who is recently engaged) and Scott Fullam, '89, were there, as were Harold Christy (Harvard, '87) and Nat St. John, Neil Peretz, and Harry Register (all Tufts, '89)." Chuck should be out of the army by the time you read this and in graduate school at the University of Alabama in Tuscaloosa, where he expects to receive a degree in finance by next summer.

Early one morning, I bumped into **Emilio Lopez** while we were both taking our cars into the shop for repairs. (I knew that he was an MIT alumnus by his Course X T-shirt.) Emilio works for the Chemcut Corp. as an applications engineer, and transferred here from Dallas last January. He just bought a house and seems to be glad to be back in Austin. He also told me that fellow Kappa Sig **Mickey Cantu** lives in Houston, where he is working for a law firm.

I was recently in Boston for the Alumni/ae Leadership Conference, where I shot a few rounds of pool with **Tom Abell** and **Peter Scully**, who are sharing an apartment near BU. Pete is currently working for Lotus in Cambridge, where he is writing software applictions. Tom, as was reported last month, is back at MIT, where he is in the Leaders for Manufacturing Program at the Sloan School. Also studying in the program is **Rhonda (Fullerton) Reynolds,** who is currently on leave from Boeing in Seattle. . . . Hope that everyone has a great holiday season! If you do anything exciting (or know a classmate who does), write in so we can all hear about it.—**Jack Leifer**, 2703 Swisher St. #202, Austin, TX 78705, (512) 472-7507, e-mail: leifer@ccwf.cc.utexas.edu

88 5th Reunion

Happy Holidays! It's hard to believe that this year is our 5th Reunion! Seems like just yesterday we were applying to countless grad schools, going on unending interviews, or just trying to figure out what to do with ourselves. (I don't know about the rest of you, but I'm *still* trying to figure out what to do with myself!) From now until the reunion, we'll be including updates in this column on reunion planning activities. The reunion is set for June 3-6, 1993, so mark your calendars! Our reunion chair is **Jocelyn Koehler** (formerly Valderrama). Since the summer, Jocelyn has been busy forming a reunion committee and gathering ideas for events. Any new ideas are certainly welcome!

Our Reunion Gift chair, **Christine Chu**, will be organizing the effort to raise funds for the Class Reunion Gift, which will be presented at the reunion. Christine has been busy setting goals for our class and recruiting classmates for the committee. Each committee member will be contacting many of you to discuss making a donation to our Class Gift as well as to bring you up to date on reunion happenings. Committee members include **Douglas Clavenger, Diane Duckworth, Tracy Gabridge, Craig Jungwirth, Debbie Lee, Martha Lyman, Lisa Martin, Kelly O'Neill, Anthony Ohrene, Gary Webster, Earl Yen, Ken Yu, Kimber**

The wedding of Debbie Lee, '88 (center, with flowers), and Javier Tam, '88, last August 1 in Austin, Texas, was attended by many of their MIT friends: Philip Sanchez, '85; Min Tung, '90; John Ma, '91; Diane DiMassa, '88, SM '89; Carlos Flores, '87; the bride and groom; Darlene Flores, '88, SM '89; Mike Mills, '89; Veronique Stassen Bartman, '89; George Deltas, '88; and Wilson Wong, '89.

Lynn Zinger, and **Mike Couris**. So there has been a great show of enthusiasm and support for our class and the reunion! Keep up the good work!

Scott Lichtman writes about his biannual move, this time to Harvard Business School where he will be living on campus at Hamilton. His company, Deloite and Touche, is paying tuition. Sounds like a pretty cushy deal! Scott had lunch with **Brenda Chin** in New York, where she is enjoying "VC" (that's Venture Capital for us lay people). Scott also ran into **Andrea Wong** at Stanford Business School while he was scouting out the program. He reports that she is having "fun in the sun."

Lori Preece and Greg Shervood ('89) were at the wedding of **Holly Tsakiris** and **Dave Horrigan** back in August. She ran into several alums, including **Glenn Cooper**, Pat and Tracy Gabridge, **Rob Shaw, Doug Bea**, and Jessica Marcus ('89). . . . Lori and Greg are living in Fairfax, Va. She got an MBA from Boston University in December 1990 and now works for the American Trucking Associations doing tax policy analysis. . . . Pat and Tracy just bought a new house in the mountains outside of Denver. Pat is doing some playwriting and Tracy still works for AT&T. . . . Rob is back in grad school at University of California-Davis. . . . Doug is working at Chevron in San Francisco. . . . Holly and Dave took a three-week honeymoon in Hawaii. Holly is doing graduate work in economics at Berkeley and Dave is doing computer consulting.

James Gill graduated from the University of Connecticut Medical School in May and is doing a medical internship at the University of Vermont Medical Center in Burlington. . . . As for me, I'm beginning my fourth month (remember, I'm writing this in September) of surgery internship at New York University. The program "eased" me into things by starting me out on trauma at Bellevue (yes, the infamous Bellevue), followed by cardiac surgery. Yes, they are trying to break me, but it won't happen! However, in the midst of things, I did miss the last *Technology Review* deadline and I apologize profusely. Let's keep the news rolling in!—**Grace Ma**, secretary, 155 East 29th St., #32H, New York, NY 10016, (212) 447-1925

89

Happy New Year! I'm sure many of you were wondering what happened to last month's article. Since I sent it in way too late, here it is this month combined with a lot more news from this month. Sorry about missing the deadline.

I've been informed that our class left the Institute without paying off a lot of debt, so we will be trying to start a fundraiser for our class which I hope we can continue as a year to year activity—that is, we will be publishing a Class of '89 Calendar. So, we're issuing a call for pictures —of you and other MIT alums, pictures of MIT Alumni/ae Club events, gatherings of classmates, wedding pictures, pictures of your children, anything with you! *Tech Review* now will be publishing photos as well, so some of the pictures you send in may be in this section, while we hope to include most others in the wall calendar. Please let others you run into know about the calendar, and ask all your friends to send in pictures. So, here we go...

Well, there wasn't much news again this month, so I'm going to encourage the following people to write in: **Charles Fabian, Michelle Nagel**, and **Linus Wang**. So, please let us know how you are, and if anyone happens to know what any of our "select classmates" are doing, please write also! Thanks!

Laura (Ryzowicz) Rapicioli and husband, Mark, '87, recently had a baby boy, Dominic, born June 23, 1992. Laura and Mark are currently living in Stratford, Conn. (My apologies to Laura and Mark for missing this information in the last issue.). . . Lori Aronson married **Mark Andersen**, and they moved back to the Boston area in August. Lori is finishing her last year of med school, and Mark is finishing a PhD in political science at Harvard. . . . **Krista Pastrone** writes that she and Craig "had a baby boy on March 20th—John Francis. He is so much fun and so much work at the same time! I am going to stay home with him instead of working outside the home. By the way, taking care of a baby is ten times harder than any course at MIT (you think a couple of all-nighters are rough—try not sleeping more than three hours/day for seven weeks!)" Krista and Craig recently moved to Corning, N.Y., where Craig has gotten a job with Corning corporate engineering. Krista also writes that **Catherine Rocchio** married Sean Garrett, '88, on August 1st in Shearborn, Mass. . . . **Karen Gold** and her husband Tim Lash, '87, are enjoying their new home in Arlington, Mass., with their two cats. Special thanks to Krista, who took time during their move to heed my desperate calls for news (so I'll add that she would like to congratulate Laura Rapicioli on her first child, and pass along a message to Alissa Fitzgerald, '90, who should look up Craig's brother Mark, who will be starting at OSC in September).

Last June **Mike Polley** and **Raj Aggarwal** were married in Austin, Tex. Raj writes that "the event turned out to be quite a reunion. Members of the wedding party included **Jennifer Lloyd** and **John Apostolopolous** (both at MIT grad school), **Paolo Sechi** (now engineering and racing motorcycles at SRI), and **Ken Patrick** (now a bank exec in Chicago). Susie Wee, '90, Kathy Krisch, '86, and John Paul Mattia,'86, (all at MIT grad school) flew in from Boston; and Yvette Ma, '90, (now at Oracle) came from California. Yvette also managed to catch the bouquet. Joe George, '90, (now working for TI in Houston), Mike Carlson, '88, (now working but mostly sailing in Austin), and James Ooi, '91, (now co-oping in Dallas) also joined the party. Providing a blast from the past was Dean Collins, '58."

Raj continues, "The weekend can best be described in three words: beer, sunburn, food (in that order). Everyone got into the partying mood, and spent most of their waking hours with a drink in their hands. Jen and John Paul tied for the 'lobster tan' award. And everyone ate to their hearts content. We spent our honeymoon in Kauai, Hawaii, mainly snorkeling and hanging out on the beach."

Jeffrey Berg is employed by the University of California at the Lawrence Livermore National Labs. Jeffrey is researching the vulnerability of satellite platforms and concepts to enhance their survivability. . . . **Mike Petro** has left industry last January to begin a PhD program in computer vision at the University of Michigan. . . . **Joseph Garrison** is currently in the western Pacific aboard the amphibious transport dock USS *Duluth* on a six-month deployment which began in June. Joseph is participating in various operations and training exercises with the Amphibious Ready Group. The ARG's first stop was in Pearl Harbor, and later stops included Subic Bay in the Philippines, the Persian Gulf, and Perth, Australia. . . . **Charles Lee** and **Paul Tiao** are in their second year at Columbia Law.

Well, that would have been all the news for this month, had I not missed the deadline by a few weeks and had the chance to attend several weddings: **Suzanne Driscoll** and Andrew Plump, '87, were married on September 5th, in the chapel at C. W. Post in Brookville, N.Y. Patricia Driscoll, '88, was the maid of honor, and **Lisa Carskadden** was one of the bridesmaids. Also present at the wedding were Janet Zahradnik, '87, Dan Kennedy, 87, Joycelyn Koehler, '88, and Dave Koehler, '88, **Sonya Hwang** (who is currently on assignment in San Francisco), **Cristine LeViness**, Rob Carskadden, '89 (who is in business school at Columbia after moving back to Fort Lee with Lisa), Scott McFarland, '88, and his fiance, Becky, **Mike Mountz**, Mike Decker, '87, **Phil Kim**, Phyllis Krystal, '88, **Doug Vincent** and Karla Kapikian, '88. I've left out a lot of people, but I'm sure Suzanne and Andy will fill me in. Following a 10-day honeymoon in St. Thomas, Suzanne will be studying for her orals, and then take a 6-month leave of absence from Stanford to do some research at Rockefeller, where Andy will be finishing in June 1993. They will move to Stanford, where Andy will finish med school at UCSF.

Suzanne was nice enough to drop a note when she and Andy returned from St. Thomas: "The islands were great. I went snorkeling for the first time (and second)...We went on an all day sail. Andy and I also went to St. John on two separate occasions (not including the sail). We rented a jeep and drove around the national park which makes up about three-quarters of the island. There were some really incredible views. Plus, we saw some wild donkeys and mongooses."

Shirley Chang and Scott LeMay were married on September 12th in Northboro, Mass. Sandy Serkes, '90, was in the wedding party. Present at the wedding were Aaron Goodisman, '90 (Sandy's fiancee), myself, **Andy Shaw**, who just returned from spending a year in Japan, **Derek Chiou, Tim Sulzbach, Sam Druker**, Anna Cinniger, SM '91, Ivanie Yeo , '92, **Ron Koo**, who is quite active in the Alumni Club of Southern California. Also, **Rosanne Park**, who is working for Objectivity in the Bay Area, Armando Fox, '90, who finished a master's in electrical engineering at UIUC and is now working for Intel in Portland, Ore., Lori Swenson, '93, who hopes to enter into an MD-PhD program next year, **Debbie Schnek**, who is working on a PhD in chemical engineering at CalTech, **Jerome Meier** and **Amy Meyers**, who are both starting their first year of B school at Harvard, and Lissy Griginsky, '91, who is in med school at the University of Chicago.

Shirley and Scott left for a honeymoon in Hawaii, the day after hurricane Iniki. I am hoping that Shirley will send a report when she returns.

Ben De Sousa just started graduate school at Boston University's College of Communications, working toward an MS in film production (a two-year program). Ben worked for GM in Flint, Mich., for two years. Now he is living near Central Square in the apartments right in back of the house of **Derek Chiou**, whom I ran into last night (not literally) because I've been parking my car in front of his house. Ben is living with three MIT PhDs and Gus, his 20-pound cat.

David Goldstone writes, "After a pleasant first year of law school at the University of Pennsylvania, I decided that I missed Cambridge too much to stay away and I had to come back. So I transfered to Harvard Law School where I am now in my second year of law school. I am very happy to be back, and I have visited with **Ira Scharf**, who is now attending MIT as part of the master's in ndustry program with BB&N. I have also visited with Yonald Chery, '88, who is a grad student in Area 3 and an RA at Bexley, and Helen Lin, '90, who is a third-year med student at Tufts. Both are doing great, although Helen will have a tough rotation in October."

Stone continues, "This summer, I was an usher for **Erik Ordentlich**'s wedding to Paohua Kuo, '88, out in Palo Alto. (Both are grad students at Stanford). I stayed with **Curtis Chen**, who is working for Oracle. Curtis is having a lot of fun in northern California, with frequent trips into San Francisco. Curtis is a star on a hockey team out there, and has season tix for the Sharks! Curtis and I went to the Gilroy Garlic Festival with **Eric Tang, Chuck Rosenberg**, and **Luis Rodriguez**. The GarlicFest was fantastic, with garlic beer, garlic wine, garlic ice cream, garlic salmon, and of course garlic bread. A good time was had by all."

Murphey Johnson was recently designated a naval aviator. Murphey was awarded the "Wings of Gold," which marked the culmination of months of flight training at Training Squadron, Naval Air Station Chasefield in Beeville, Tex. . . . **Roger Horton** is currently participating in a five-nation maritime exercise aboard the submarine USS *Los Angeles*, homeported in Pearl Harbor. The exercise, in the eastern Pacific between Hawaii and California, was designed to improve the tactical capabilities of all participating units. . . . Following a six-month deployment to the western Pacific and Persian Gulf, **Joseph Garrison** recently returned to home port in San Diego. Joseph, aboard the USS *Duluth*, participated in separate exercises with the Kuwait

armed forces and Thai armed forces.

Thanks to all for writing, and I'm sorry to all (especially Krista and Laura, whose news would have appeared last month) about missing the last deadline. Please write, and send pictures for the calendar (and *Tech Review*), too! We're aiming for an August delivery of the school-year wall calendars. —**Henry Houh**, secretary, 4 Ames St., Cambridge, MA 02142, phone: (617) 225-6680, e-mail: tripleh@athena.mit.edu or henry_houh@mit.edu

90

Not too much news to report this time, but now that I have an e-mail address, I hope more of you will be writing! . . . Ever since graduation, **Joon A. Ooi** has been working for Intel in Penang, Malaysia. The Intel branch in Penang is the first offshore assembly plant for the Intel Corp. Joon began his stay at Intel as a mechanical engineer but never did much designing work. Instead, he ended up doing more project management tasks and is now project manager in the Ceramic Packaging Technology Development Division. His current responsibility is to manage the technology development line, a pilot manufacturing assembly/test line responsible for supporting the development and certification of new ceramic technology as well as new silicon technology in ceramic packaging. This assembly/test line was basically put in place to find out the manufacturability of the next generation of microprocessors, such as the 586 and 686.

Jamie Wong has finished the classroom work part of Tufts Medical School. She is now beginning her rotations in Bangor, Maine. . . . **Jessie Wong** is working for Myers-Holum and has spent recent months working outside of New York City on a consulting project for *Readers Digest*.

Some news from the West Coast. . . . **Agnes Santosa** and **Cathy Su** are both studying at Stanford Medical School. Cathy has just started her rotations. . . . **Cindy Mok** is working for a consulting firm in Mountain View, Calif., after getting a master's in industrial engineering from Stanford. . . . **Ken Lu** has put his PhD ambitions at Stanford on hold for awhile in favor of working at Oracle and getting paid! To celebrate, he spent a one-week marathon session completing all of the 90+ levels in Nintendo's Super Mario World.

Over the summer, **Carl de Marcken** worked for Sun Microsystems and prepared for his annual trip back to the great lakes of Minnesota by making a canoe. . . . Congratulations to **Oggi Park** and **Ernest Lin**! They were married on March 28 in Virginia. **Agnes Santosa** and **Cathy Su** were respectively the maid of honor and bridesmaid. The best man was **Eugene Lu**, and one of the groomsmen was Ernest's brother, Daniel Lin, '86. A whole contingent of MIT people were present at the wedding. Oggi and Ernest thank everyone for attending and making their wedding so special. Oggi and Ernest now live in San Jose, where Oggi is a design engineer at Wiltron, and Ernest is a process engineer at Komag.

Congratulations also to **Dick McGrath** and Jessica Johnson (Simmons, '91)! They were married on August 29 in Atlanta, Ga. In attendance at the wedding were **Zach Ambrose**, **Gerardo Capiel**, **Rock Fu**, **Jess Gaspar**, **Paul Grim**, **Clint Grimes**, **Chris Jalbert**, **Charles Mansfield**, **J.T. Raffle**, and **Luke Ramsey**. Dick is currently a student jet pilot in the U.S. Navy at Kingsville, Tex., and he also serves in the same squadron as **Scott Moran**. Zach is a U.S. Navy surface warfare officer based in South Carolina. . . . Gerardo is working in San Francisco after recently returning from an excursion to Costa Rica. . . . Rock is working in Los Angeles. . . . Jess has returned from working in Paris, France, and is now a graduate student in economics at Stanford. . . . Paul is still working in Paris, France. . . . Clint is a project engineer with the Saturn Corp. . . . Chris is living in Maine and designing aircraft engines for Pratt-Whitney. . . . Charles was also recently married and lives in New York. . . . J.T. is completing his third year at Duke Law School. . . . And Luke has finished working for Teach for America in Los Angeles and is currently living in Washington, D.C.

Jema Gonzales recently quit her job at Cambridge Technology in order to pursue an MBA. After receiving acceptance and in some cases merit fellowships from Harvard, Wharton, and Columbia, Jema decided to attend Wharton. There she is one of only 250 people testing out a pilot program for Wharton. This pilot program will be officially integrated into the required Wharton curriculum next year. At Wharton, Jema has already run into a handful of MIT alumni/ae!

Out on the East Coast. . . . **Teresa Zimmers** is working for the NIH in Bethesda, Md. . . . Also in Bethesda is **Ken Battige**. Ken is working for the Nuclear Regulatory Commission. . . . And back at the Institute, at the annual MIT Alumni/ae Leadership Conference in late September, I ran into **Mini Gupta**, **Julie Kim**, and **Amos Leung**. Both Mini and Julie are working as consultants, and Amos has just become an MIT educational counselor in the Detroit metropolitan area.

Well, that's it for this time. Hope everyone had a wonderful holiday season! Since things seem to always be kind of slow in the winter, I hope you'll all find some time to send some news.—**Ning Peng**, secretary, 305 Ashdown #203A, Cambridge, MA 02139 or ning@athena.mit.edu

91

"Greetings from St. Louis!" writes **Tom Cole**. "I recently transferred from Princeton, N. J., to St. Louis. I am working for General Electric as part of their manufacturing management program. I went from building satellites to making light bulbs." Tom is presently a process engineer in GE's manufacturing engineering department and he plans to move back East after a year in the nation's heartland. Tom sends news about several classmates. During GE's training course in New Jersey, he saw other GE protegés: **Laura Pitone**, **Felipe Calderon**, and **Tim Fox**. In July, Tom, **Steve Tucker**, and **Jeff Myjack** went mountain biking and stayed at Jeff's lakeside cabin in New Hampshire. Tom, Steve, Jeff, and Brad Layton, '92, met again at a crew race in Camden. For July 4th, Jeff, Laura, and Tom travelled to Washington, D.C., to see the fireworks. Laura is now living in Memphis and, like Tom, is building lightbulbs.

Sharra Davidson sends news that she read a psalm from the "Song of Solomon" at **Chris Masalski**'s and Amy Franz's (Wellesley) wedding. **Jason Oliver** was a member of the wedding party. Sharra also mentions that **Ed Munnich** is teaching again in Long Beach and that **Mike Mitchell** bought a townhouse in Minnesota.

Paul Antico is now the "telecommunications equipment analyst" at Fidelity Investments. Paul and **Marc Kaufman**, who covers the stocks of small companies in a variety of industries, share an office at Fidelity. That means that Paul, who is still my roommate, now holds the dubious honor of having one classmate as a roommate and another as an officemate. On Paul's recent research trip to California, he went with **Steve Lotwin** and Sue Serkes, '92, to a Tex-Mex bar and grill in Los Angeles. Steve is a second year law student at UCLA, and Sue and **Julie Oh** work in different offices in LA for Andersen Consulting.

Big brother really is watching: the New England Newsclip Service clipped an article from a Connecticut paper about **Kim Mislick**. Kim is pursuing a PhD in chemical engineering at Caltech and is working with a professor known for his work in air pollution modeling.

Mauricio Roman sends a colorful postcard of Berkeley's Wheeler Hall. He is working toward a master's in civil engineering at Berkeley. He had recently met with **Shawn Rothstein**, who is working for Bechtel, and **William Bankhead**, who is pursuing a PhD in political science at Berkeley. . . . **David Rothstein** sends a postcard from Houston, where he now lives. He has put off medical school for another year, this time to work in Chris Platsoucas's (PhD '78) laboratory in the University of Texas's Department of Immunology. "Having grown up in Massachusetts," writes David, "It still amazes me that I can drive five hours in all but one direction and not leave Texas!" David is completing his paramedic training and is riding a lot with volunteer 911 emergency medical services. David has seen **Chris Sonne**, who is in his first year at the Baylor College of Medicine and Eugene Liu, '90 (a third-year at Baylor Med).

Speaking of postcards, some time has passed since one arrived and flushed the cobwebs out of my mailbox. I look forward to hearing and writing about your newest pursuits. Please write to: **Andrew Strehle**, secretary, 12 Commonwealth Ct. # 10, Boston, MA 02135, (617) 232-2261.

92

Different till the end! The Class of '92, the first class in 10 years to have its commencement exercises held indoors, will never be forgotten. Though it rained on our parade, we have made it into the world of MIT alumni. Congratulations and welcome! This is my first column of class notes, and for those of you who don't know me, my name is **Leslie Barnett** and I will be serving as your secretary for the next five years.

Congratulations to **Diane M. Velez** on her marriage to **Edouard A. Garcia**, who is an MIT graduate student in electrical engineering. Diana is currently working on a master's in the Leaders For Manufacturing Program. . . . Marine 2nd Lt. **Melissa D. Kuo** and Navy ensigns **Joseph E. Dennis**, **David E. Gustafson**, **Gustavo Gutierrez**, **Robert B. Pember**, **Christopher M. Rein**, **Timothy A. Salter**, **Jason B. Slibeck**, **Kurt M. Steltenpohl**, and **Ben J. Weintraub** were commissioned upon graduation from the Naval Reserve Officer Training Corps (NROTC) Program.

Jody Buzanoski will be starting the Environmental Engineering Science Program at Stanford University this fall. . . . **Savoy Rose Jade** has been busy launching a South Shore chapter of N.O.W. and has started attending law school. . . . **Seema Dwivedy** will be working for IBM in Austin, Tex. . . . We have a number of classmates working at financial investment companies in New York City, including **Aileen Lee** at Morgan Stanley; **Paul Kan**, **Eddie Lee**, **Zain Abdullah**, **Wes Carroll**, and **Judy Chin** at First Boston; and **Alison Williams**, **Soo-Ah Kim**, and **Jennifer Singer** at Goldman Sachs.

This summer there were many adventurous spirits making their whirlwind tour across Europe. Among those I ran into were **Paul Tompkins** and **Pete Wainman** in Cordoba, Spain; **Daniel Zentner** in Nice, France, and again in Florence, Italy; and **Lee Morgenroth**, whom I traveled with en route to Greece for a stay on the island of Santorini. . . . **Joanna Stone** was in China for a month doing a workshop with the Department of Urban Studies and working on a master's thesis. She spent some time in Japan as well.

Other travelers include **Jill Soley**, **Ava Kuo**, and **Mark Duggan**. . . . Ava is working for I.C.F., Inc., in the D.C. area and would like to hear from anyone in town. . . . Mark has been doing a lot of work recently for our Class Gift project, the Program for the Encouragement of Technology (PET). I'd like to applaud the effort put forth by our class for this project. We aimed high and accomplished our goal of raising $10,000 this year, but the work is far from over. If anyone can offer ideas, suggestions, or help, please contact me or any of the class officers.

In order to keep this column informative and interesting, I need your help. What did you do this summer? Your classmates want to know where you are and what you are doing. Please send your news to me so I can keep the class abreast of our latest news and keep our network going.—**Leslie Barnett**, secretary, 56 Brown St., Mineola, NY 11501

COURSE NEWS

I CIVIL ENGINEERING

Miguel Stanichevsky, SM '82, sends word from Asunción, Paraguay: "I am the current president of the Paraguayan Geotechnical Society. I work as an independent consultant and as professor at the Catholic University of Asunción, where I teach geotechnical engineering at the School of Technology. I am also associate VP at N. Sryvalin & Associates, a well-established construction and design company in Paraguay." . . . **Sadaaki Kuroda**, SM '67, reports: "I am now working for Japan Railway Technical Service (JARTS) as a senior executive VP. JARTS is a sole representative for international cooperation of Japan Rail Group (the former Japanese National Railways). We are now involved in the high-speed railway projects in Korea and Taiwan. We are also involved in the improvement of urban transport in Jakarta, improvement/rehabilitation of Sri Lanka's railways, privatization of urban transport of Buenos Aires of Argentina, etc."

Edwin C. Rossow, '59, PhD '64, is one of four to be named the first Charles Deering McCormick Professors of Teaching Exellence at Northwestern University in Evanston, Ill. The professorships were established with a $10 million gift from McCormick to recognize tenured faculty "who have consistently demonstrated outstanding performance in the classroom or who have developed significiant innovations that also have influenced the methods of teaching effectiveness of other members of the faculty." Rossow will serve three years, with an annual salary supplement, plus support for professional assistance, research expenses, travel, and other related activities. He will also be a Fellow of the newly established Center for Effective Teaching. Rossow was called "an outstanding lecturer and advisor . . . he epitomizes the very best in teaching . . . and has maintained that eminence during his entire 27-year career" at Northwestern, according to a university news release. Rossow, associate professor of civil engineering, has received several teaching awards since joining Northwestern in 1965.

James Wallace Daily, MIT Course I professor from 1946–64, died on December 27, 1991. Daily was recognized for his research in fluid engineering. In 1946 he joined MIT's hydraulics faculty and helped found the MIT Hydrodynamics Laboratory. In 1951, Daily took up research on transient flow and cavitation and he became a full MIT professor in 1955. In 1964 he accepted an invitation to become chair of the Department of Engineering Mechanics of the University of Michigan in Ann Arbor. He held this position until 1972 when he returned to teaching and research, retiring in 1980. The University of Michigan appointed him Professor Emeritus of Fluid Mechanics and Hydraulic Engineering.

II MECHANICAL ENGINEERING

Edward K. Levy, SM '64, ScD '67, professor of mechanical engineering and mechanics and director of the Energy Research Center at Lehigh University in Bethlehem, Pa., has been honored for 25 years of dedicated service. Levy specializes in fluidization, convective heat transfer, rotating flows, and performance optimization of power generation systems. He received Lehigh's Lindback Award for Distinguished Teaching in 1972, and was listed in *Outstanding Educators of America*. Research supporters have included the Atomic Energy Commission, the NSF, and Pennsylvania Power and Light.

J. Arimond

John Arimond, SM '84, has been promoted to senior design research engineer at Rogers Corp. in Rogers, Conn. Arimond, most recently a research engineer with the company, has been at Rogers since 1985. While at MIT, Arimond's focus was on mathematical modeling. He is a senior member of the Society of Plastic Engineers and a member of the SAE. He lives in Brooklyn, Conn., and often performs as a singer in local coffeehouses and theatre productions. He also serves as president of the board of directors for Literacy Volunteers of America's Quinebaug Valley Chapter. In his new position, Arimond remains at Rogers' Lurie Research Center, where his research involves the development of composite design rules and the support of automotive applications development for moldable phenolic composite materials.

Je-Chin Han, ScD '77, a professor of mechanical engineering at Texas A&M University, has been named a Fellow of ASME. Han is a registered professional engineer in Texas and member of the ASEE and AIAA.

John C. Chato, PhD '60, professor of mechanical, electrical, and bioengineering at the University of Illinois at Urbana, has received the H.R. Lissner Award of ASME. Established in 1987, the award is named for Professor Lissner, a pioneer in biomechanical research at Wayne State University, and recognizes outstanding achievement in bioengineering. Chato was cited for "pioneering contributions to the development of the field of bioheat transfer, including numerous landmark research advances, and for exceptional leadership in mentoring a subsequent generation of investigators." Chato's research and teaching, documented by more than 100 technical papers and reports, has dealt primarily with thermal analysis and heat transfer, including cross-disciplinary problems (such as biological heat transfer and electrohydrodynamics), two-phase flows, and optimization techniques. An ASME Fellow and recently elected to the ASME Bioengineering Division's executive committee, Chato has served as associate editor of the *Journal of Biomechanical Engineering*.

Miguel C. Junger, '44, SM '46, chair of the board at Cambridge Acoustical Associates, Inc., in Cambridge, has been given the Per Bruel Gold Medal by ASME. Honoring Per Bruel, who pioneered the development of highly sophisticated noise and vibration measuring and processing equipment, the medal recognizes eminent achievement and extraordinary merit in the field of noise control and acoustics. Junger received the medal for "seminal work in the field of interaction of sound and structures and for extensive contributions to the field of noise control." Junger worked as a research fellow at Harvard Acoustics Research Laboratory for four years before founding Cambridge Acoustical Associates with his colleague P.W. Smith, Jr., in 1955. Even though he served as president from 1959 until 1989, when he was named chair of the board, he remained active in research. In addition, Junger served as a senior visiting lecturer in MIT's Department of Ocean Engineering from 1968–78. . . . **Robert H. McEntire**, SM '69, ME '70, PhD '71, and his wife, Elona, recently celebrated their 25th wedding anniversary.

III MATERIALS SCIENCE AND ENGINEERING

Frank F. Aplan, ScD '57, is this year's recipient of the Antoine M. Gaudin Award of the Society of Mining, Metallurgy, and Exploration for his work in coal preparation. The award is named for the late A.M. Gaudin, the Richards Professor of Mineral Engineering. Aplan was one of the students in his group while at MIT. . . . **W. David Kingery**, '48 (V), ScD '50, is the editor of *Technological Perspectives on Behavioral Change* (The University of Arizona Press, 1992), a book written by Michael Brian Schiffer. This book is the first volume in a series that Kingery says, is "meant to offer anthropological studies of recent, historical, and ancient technology." Both Schiffer and Kingery are on the faculty of the University of Arizona. This first volume and all others in the new series will share an anthropological viewpoint that human culture, behavior, perceptions, and social organization are core considerations in technological practice, innovation, and change.

Michael B. Bever, SM '42, ScD '44, a retired Course III professor and founder of the scientific study of recycling, died on July 17, 1992, in his Cambridge home. An outstanding metallurgist, Bever pioneered the application of thermodynamics to the mechanical properties of metals. He was also a leader in the use of calorimetric techniques to explore the energetics of the ordering of atoms in crystalline structures. During this period, he became one of the first practitioners of the emerging field of materials science and engineering. In the early 70s, Bever became interested in conservation and recycling, particularly the environmental and economic aspects of the production and consumption of materials. Drawing on his background in law, management, and metallurgy, he developed an integrated scientific approach to recycling. He received an award from the National Association of Secondary Materials Industries in 1972 in recognition of creating the first course in the country, if not the world, on the economics and materials aspects of recycling. He was the author of more than 150 scientific papers and editor of several books. His culminating contribution was as editor-in-chief of the innovative and comprehensive eight-volume *Encyclopedia of Materials Science and Engineering* (Pergamon Press, 1986). The weeks before his death he completed editing the *Concise Encylopedia of Materials Economics, Policy, and Management*, one of several supplementary volumes that followed the original work. Bever taught at MIT for more than 50 years.

IV ARCHITECTURE

Sarah Abrams, SM '85, has joined U.S. Trust Co. as VP of real estate owned. Prior to joining U.S. Trust, Abrams was a principal with The Trover Co., a Boston-based real estate development and consulting company she founded. Before that she served as a senior project manager with The Kirkland Group. She also currently serves as an adjunct associate professor of law at the Cornell Law School, where she teaches a course on the legal aspects of real estate development. Abrams is a member of New England Women in Real Estate and the Massachusetts Bar Association and an affiliate member of the Boston Society of Architects. At U.S. Trust, she and one other colleague are responsible for all of the properties acquired by the bank via foreclosure. The properties include residential homes, office buildings, apartment complexes, retail centers, and land. Her responsibilities include managing, marketing, permitting, and selling these properties. . . . **Beth Galston**, SM '81 recently had an exhibition at the Bunting Institute in Cambridge. Her creation was a walk-through, sculptural "garden" environment made of translucent architectural forms in perforated aluminum that responded to changes in light. The work was scaled to the human body, and included serpentine paths to walk on, intimate "bodyhouses" to walk into and through, sculptural seats, and miniature house forms that played off the pastel pink Victorian building of the site. For the last decade, Galston has built large-scale interior environments and participated in collaborative multimedia performances.

S. Abrams

John I. Carlson, Jr., of Winchester, Mass., died on June 25, 1992. He was a senior lecturer for the Center for Construction Research and Education at MIT, retired commissioner of the Massachusetts Division of Capital Planning and Operations, and retired president and CEO of the Carlson Group, Inc. Carlson served as a Navy officer in WWII.

The Association of Alumni and Alumnae has been notified that **Sandra A. Wadsworth**, MAR '74, of Brookline, Mass., died on September 15, 1991. No further information was provided.

V CHEMISTRY

The past year has been very full for **George Epstein**, SM '52. On November 1, 1991, he retired from the Aerospace Corp. in El Segundo, Calif., where he directed the Manufacturing Technology Department. Last June, the Society of the Plastics Industry gave Epstein the Western Plastics Man-of-the-Year Award. He was cited for his "numerous and significant contributions to plastics technology and education, which have benefited not only the plastics industry, but also the aerospace/defense industry—including a key role in gaining acceptance for composite materials and structures in many important space and defense systems." . . . **David W. Ellis**, PhD '62, president and director of the Museum of Science in Boston, was recently profiled in the *Boston Business Journal* (July 1992). The article details how in just two years Ellis has brought financial stability to the museum with his energy and enthusiasm. Ellis spent 12 years at Lafayette College, after 16 years as a chemistry professor and administrator at the University of New Hampshire. In the past, Ellis has demonstrated tremendous fundraising skills, which he will implement in the coming months as the museum continues toward its new look, according to the article. . . . **Alexander M. Klibanov**, Course V professor, was awarded the 1991 International Enzyme Engineering Award. The award is presented biannually by the Engineering Foundation and Genecor for new discoveries, research process or device development, or methodology relating to scientific or engineering achievements in the area of enzyme engineering. Klibanov, who is the first American to receive this honor, was cited for his "pioneering work on enzymatic catalysis in organic solvents and mechanisms of enzyme inactivation."

The Association of Alumni and Alumnae has been notified of the following deaths: **George G.C.K. Mah**, PhD '48, of Evanston, Ill., on May 28, 1990, and **William R. Downs**, PhD '39, of Louisville, Ky., on June 22, 1992. No further information was provided.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Arthur L. Fox, SM '72, writes: "I am involved in mentoring and financing technology companies at start-up and early development stages." . . . **Gerald B. Kliman**, '55, SM '59, ScD '65, writes: "I was recently elected a Fellow of the IEEE for 'contributions to linear induction motors and liquid metal pumps and to passive current fault diagnostics for electric motor systms.' I have been at General Electric's Corporate R&D Center in Schenectady, N.Y., since 1978 after tours at the Transportation Division (Erie, Pa.), and Nuclear Division (San Jose, Calif.), since 1971. Prior to that, I had been assistant professor of electrical engineering at RPI in Troy, N.Y. While still at MIT I married the former Edith Moses out of Wellesley College and now have two fine sons, one of whom is completing a master's in mechanical engineering and the other about to enter medical school. I still play the violin in a local orchestra. I am currently heading up a project of the orchestra in cooperation with an inner city, after-school art center to try to stimulate an interest in mathematics among the children. The central theme of the project is fractals, which will be approached on two fronts. One is a special musical presentation illustrating fractal constructions in sound which will be presented by the orchestra. The other will consist of art projects, again based on fractals, carried out by the children in the weeks preceding the performance which is scheduled for November. A videotape explaining and demonstrating the concepts at a suitable level for children is being made." . . . **Kenneth R. Myers**, '60, is one of four editors of *Environmental Spill Reporting Procedures Handbook* (Clark Boardman Callahan, 1992). "The handbook covers the laws and regulations of 50 states, D.C., Puerto Rico, and the federal government, regarding reporting obligations in connection with accidental spills and similar events," states a press release. Myers is an environmental lawyer with the firm Morgan, Lewis & Bockius in Elkins Park, Pa. . . . **Monson H. Hayes, Jr.**, SM '49, has retired as president and COO of Maxwell Laboratories, Inc., in San Diego, Calif. . . . **John J. Cimral**, SM '83, EE '83, has resigned as senior VP at Bachman Information Systems in Burlington, Mass. . . . **Ronald W. Schafer**, PhD '68, institute professor and John O. McCarty chair in the School of Engineering at Georgia Institute of Technology, has been awarded the Education Medal by the IEEE. Schafer was cited for "excellence in curriculum development, teaching, and textbooks in digital signal processing and digital speech processing." From 1968–74, Schafer was a member of the technical staff and supervisor at Bell Laboratories in Murray Hill, N.J., where he was engaged in research on speech processing and digital signal processing. At

1919-1992

Benjamin Averbach

Professor Benjamin L. Averbach, ScD '47, a materials scientist and engineer whose research and teaching ranged from steel to shellfish, died April 1, 1992. He died in his sleep at his home in Belmont, Mass., after a long struggle with cancer. He was 74.

Averbach, professor emeritus since July 1990, joined MIT in 1945 as a research assistant in what was then called the Department of Metallurgy. His BS and MS in metallurgy were from Rensselaer Polytechnic Institute in Troy, N.Y. Before joining the MIT faculty, he was a metallurgist for General Electric Co. and chief metallurgist for U.S. Radiator Corp.

Averbach published more than 200 papers on a variety of materials subjects, including transformations in steels, determinations of atomic arrangements in amorphous materials, developments of analytical techniques in X-ray, electron and neutron diffraction, and fracture phenomena in ships, pipelines, and aircraft.

For many years he was a leading researcher in a national effort that involved the MIT Sea Grant Program to develop uses for chitin and chitosan, the natural polymers derived from the shells of lobsters, crabs, and shellfish. He succeeded in turning this substance into a transparent film that is edible, biodegradable, and strong, with applications as a food wrap and as surgical dressing.

An active and highly respected consultant to industry, he was involved in the development of new materials with high-fracture toughness for bearings used in high-speed aircraft engines and gears.

Averbach was a fellow of the American Society of Metals and the Institute of Metals, and a member of the Metallurgical Society and the American Physical Society. He was past president of the International Congress on Fracture and a delegate to the International Institute of Welding. □

PHOTO: MIT MUSEUM

1903–1992

Cyril Smith

An Entire Career in Microstructures

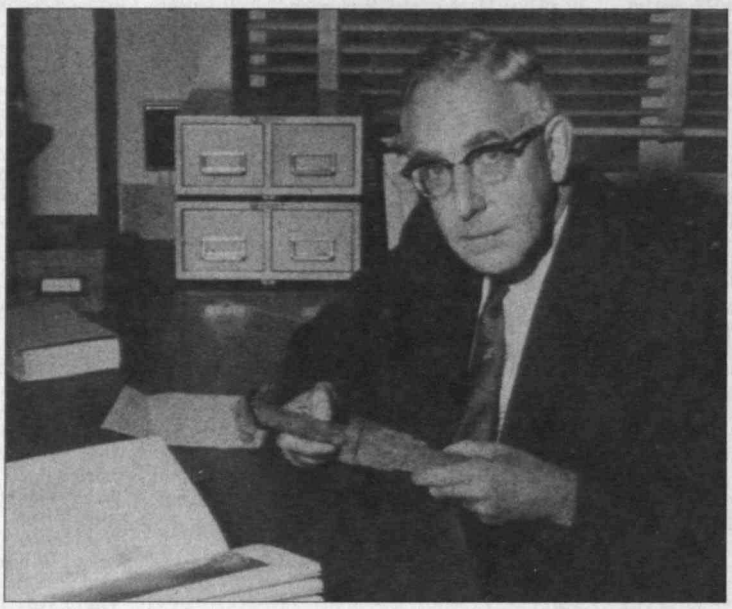
Institute Professor Emeritus Cyril Stanley Smith, ScD '26, whose deep understanding of metallic microstructures, when imaginatively applied to archaeology, created a new window on human history, died August 25 at his home in Cambridge. He was 88; death was attributed to cancer.

Though close associates were aware of his interests in ancient cultures, there was no hint in Smith's early career of the unconventional extensions that would ultimately lead to his appointment as Institute Professor at MIT. In 1924 Smith graduated in metallurgy from the University of Birmingham, England, the city of his birth. He immediately came to the United States and two years later received a doctorate in physical metallurgy from MIT. From Cambridge, Smith went to the American Brass Co., applying his knowledge of metals—their electrical and thermal conductivity, their mechanical and magnetic structures—to the company's products.

By 1942, when he was recruited for the staff of the War Metallurgy Committee in Washington, Smith held some 20 patents and had written a number of technical papers. Later he joined the Manhattan Project at Los Alamos National Laboratory, where he directed the preparation of fissionable material for the atomic bomb and other materials for nuclear experiments.

At the close of World War II, Smith was invited to head one of several new interdisciplinary activities then being established at the University of Chicago. His Institute for the Study of Metals was the first such U.S. program in the field of materials—"a natural outgrowth," he said, "of the close association of chemists and physicists at Los Alamos."

Parallel to his career, Smith was developing interests in the history of metallurgy and the relevance of metallic microstructures to the study of archaeology. When he retired from Chicago in 1961, MIT offered him an opportunity to explore those interests in an interdisciplinary academic environment. His work in a new Laboratory for Research on Archaeological Materials in Cambridge quickly became a fulfilling passion.



Before 1967, most technical studies of ancient artifacts had been done by chemists. Smith's essential contribution, says MIT Professor Heather Lechtman, was to show how artifacts' microstructures reveal details of what early humans knew about handling and processing metals. "His purpose," Lechtman explains, "was not to elucidate the history of technology but to show the cultural decisions people made in their interactions with materials.

"What he did was to inject engineering science into archaeology and to show that this was one of the most important ways to learn about the human condition," she says.

Explaining this approach, Smith wrote in *Technology Review* (June 1976, p. 38) of analyzing the products of a number of ancient artisans: "The microstructures . . . instantly reveal to a knowing eye the technical history of making the object. Such records are in a universal language, and they are free from the distortion that inevitably accompanies passage through a human mind. Through such records, I have communicated with dozens of craftsmen, including a Luristan smith of 800 B.C., a bronze founder of Shang China, an ancient Greek goldsmith, and a 13th-century Japanese swordsmith; and I have understood them better than I understand some of my English-speaking colleagues today!"

Though he was not formally affiliated with it, Smith was a major force in the establishment in 1977 of the Center for Materials Research in Archaeology and Ethnology (of which Professor Lechtman is now director) by a consortium of educational and cultural institutions in greater Boston.

At MIT, Smith had affiliations with both the Departments of Humanities and of Materials Science and Engineering, and the latter was where he found most of his professional associations. Professor Merton C. Flemings, '51, head of the department, recalls how he and many of his colleagues often turned to Smith for technical help. "He was brilliant as a metallurgist," says Flemings. "Microstructures went through Cyril's entire career. . . . He was working on ideas about structure as recently as three weeks before his death." In his autobiographical account of his work, *A Search for Structure* (MIT Press, 1981), Smith described his "aesthetic pleasure whenever a properly prepared specimen comes into focus under my microscope."

Smith also made a significant contribution, says Flemings, by expanding the department's horizons beyond technical metallurgy. Professor Emeritus Morris Nicholson, '39, of the University of Minnesota, recalls that "after every conversation [with Smith], you felt that your perspective and understanding of science were improved."

Among Smith's many honors were the Francis J. Clamer Medal of the Franklin Institute (1952), the Pfizer Medal of the History of Science Society (1961), the Gold Medal of the American Society for Metals (1961), the Douglas Medal of AIME (1963), and the Gemant Award of the American Institute of Physics (1991).

Smith was the author of four books (the latest, *From Art to Science* (1980), an outgrowth of an exhibition commissioned by the Smithsonian and MIT) and of some 200 scholarly papers.—*John Mattill* □

PHOTO: MIT MUSEUM

Georgia Tech since 1984, he has fostered research and developed courses in digital speech processing and digital signal processing, in each case cowriting textbooks that have been influential in the emergence of the fields as widely accepted academic subjects. Schafer's 1975 text, *Digital Signal Processing*, co-written with **A. V. Oppenheim**, '59, SM '61, ScD '64, the Distinguished Professor of Electrical Engineering at MIT, became the most widely used in its field.... **Ralph L. Keeney**, SM '67, EE '68, PhD '69, professor of systems management at the University of Southern California, has written *Value-Focused Thinking: A Path to Creative Decisionmaking* (Harvard University Press, 1992). According to the book's catalogue listing, "The standard way of thinking about decisions is backwards, says Ralph Kenney; people focus first on identifying alternatives rather than on articulating values. A problem arises and people react, placing the emphasis on mechanics and fixed choices instead of on the objectives that give decisionmaking its meaning. In the book, Keeney shows how recognizing and articulating fundamental values can lead to the identification of decision opportunities and the creation of better alternatives. The intent is to be proactive and to select more attractive decisions to ponder before attempting any solutions." ... **John G. Truxal**, '47, ScD '50, distinguished teaching professor emeritus at the University of Stony Brook, was presented the 1992 Sterling Olmsted Award by the American Society for Engineering Education. The award was presented in recognition of his contributions in the teaching and administering of liberal education in engineering education. A leader in defining and implementing science, technology, and society programs in the United States and abroad, Truxal was praised by the award selection committee for his advocacy and leadership in extending the study of engineering and technology to the liberal arts and challenging engineers to enrich the study of the liberal arts for engineers. His contributions as director of the Council for Understanding Technology in Human Affairs and the Sloan Foundation New Liberal Arts Program have expanded the study of engineering in contemporary liberal arts programs. His most recent book, *The Age of Electronic Messages*, provides a model for teaching technical subjects in an accessible manner to non-specialists as well as explaining the social implications of technology.

VI-A INTERNSHIP PROGRAM

What a contrast between our summer of '92 versus '91, here in the Northeast! I reread what I wrote a year ago, about our being "plagued with long spells of hot, humid weather—with many record breaking days of over 90° F. This summer saw only two days up to 90°. Several mornings lately, early September as I write, have already begun at 40°. It makes one wonder if there is a relation, somehow, between this season's coldest summer in the Northeast and the exceptionally severe hurricanes in the Western Hemisphere?This also was noticeably a quieter summer on campus. However, this has abruptly changed with the return of the upperclassmen and the arrival of 1,147 freshmen.

VI-A Director **Kevin O'Toole**, SM '57, NE '57, tells me that, as of this fall, a record 63 VI-A seniors have been admitted to the graduate phase of the program.The honor societies, Tau Beta Pi and Eta Kappa Nu, are organizing their fall activities. A VI-A'er is Tau Bate's corresponding secretary and 8 of the 10 Eta Kappa Nu Chapter Officers are VI-A'ers, including this year's president.

Joining the EECS faculty this year is **Jeannette M. Wing**, '79, SM '79, PhD '83, as visiting associate professor. Jeannette did her VI-A work at Bell Laboratories, Inc.

Contact with VI-A alums, since last writing, has included: **Steven L. Bates**, '74, SM '76, EE '76, whom I visited at his place of employment, Tau-Tron in Westford, Mass., and with whom I had a most pleasant evening dinner discussing alumni activities.... **Stephen M. Foster**, '88, SM '90, who wrote from Germany where he is working with Procter & Gamble's European Design Group near Frankfort.... **David J. Goldstone**, '91, SM '91, who stopped by the office and who is attending Harvard Law School.... **Charles W. Therrien**, '64, SM '65, EE '66, PhD '66, a full professor in the Electrical and Computer Engineering Department at the Naval Postgraduate School in Monterey, Calif., who corresponded with past VI-A Director **J.F. Reintjes**, on the occasion of Professor Reintjes 80th birthday.—John A. Tucker, director emeritus, VI-A Internship Program, MIT, Room 38-473, Cambridge, MA 02139.

VII BIOLOGY

Maria Jasin, PhD '84, was awarded the Pew Scholar Award in the Biomedical Sciences.... **Raul Rothman**, '80, assistant professor of clinical medicine at Columbia University College of Physicians and Surgeons, has been named a 1992 Pfizer Scholar. Rothman's research has centered on studies of the molecular mechanisms that control immunoglobulin heavy chain class-switch recombination. As a Pfizer Scholar, he will undertake a series of experiments to extend the understanding of these molecular mechanisms, supported by grants of $65,000 annually for two years.

The Association of Alumni and Alumnae has been notified that **John R. Segal**, PhD '59, of New York, NY, died on January 31, 1990. No further information was provided.

VIII PHYSICS

Steven K. Blau, PhD '85, has been named assistant professor of physics at Ripon College in Ripon, Wis. He is one of three professors in the Physics Department at this 800-student college. Blau's research interests concentrate in the area of theoretical particle physics and include studies in general relativity. He hopes to involve students in research in computational physics and plans to play the sax in a campus music group. Prior to this move to Wisconsin, Blau was at Amherst College in Amherst, Mass....

S.K. Blau

Michael C. Brower, '81, has recently published a revised edition of *Cool Energy: Renewable Solutions to Environmental Problems* (MIT Press, 1992). "In *Cool Energy*, energy-policy expert Michael Brower brings readers up to date about non-fossil energy technologies. Brower analyzes their near- and long-term potential and illuminates their role in global environmental protection," states an MIT Press news release. Brower, a physicist, is research director for the Union of Concerned Scientists, an independent, nonprofit organization of 100,000 scientists and other citizens concerned about national energy policy, global environmental problems, and national security policy.

Ormond Barstow, ScD '38, of Midland, Mich., died on July 25, 1992. He spent his career at Dow Chemical Co., both before and after attending MIT. He worked on instrument development in the physics laboratory at Dow upon his return from MIT. Barstow designed and built a number of innovative instruments, including a well-hole camera, a color analyzer for polystyrene, and a titration recorder for chemical analysis. Mandatory retirement in 1969 ended his creative contributions to Dow Chemical. Barstow was a dedicated member of several community organizations, including the Midland Hospital and the Delta College Foundation. He designed and built a complete weather station for the Chippewa Nature Center and was an active member of the Hall of Ideas Council of the Midland Center for the Arts. He identified and tagged more than 100 varieties of trees and bushes in the Barstow Woods (a gift of his father to the city). At age 84, after receiving a gift certificate for one hour of flight instruction from his son, he took up flying and soon recorded his first solo flight. He was finishing his requirements for a private license when he was diagnosed as having cancer in late 1991.

X CHEMICAL ENGINEERING

George Jansen, Jr., SM '57, ScD '59, a principal engineer for Westinghouse Hanford Co. in Richland, Wash., has been named a Fellow of the American Institute of Chemical Engineers (AIChE). In honoring Jansen, the institute's governing council cited his "expertise in the nuclear industry, including chemical processing of nuclear fuels, reactor safety analysis, radioactive waste management process development and safety analysis, uranium enrichment, and high-level waste repository risk assessment." Before joining Westinghouse Han-

In a U.S. Department of Commerce ceremony held last July, S. Edmund Greenfield, SM '67(VI) (right), a standards officer at the National Institute of Standards and Technology (NIST), took the oath of office for the United States and Foreign Commercial Service. He was assisted by Stanley I. Warshaw, ScD '61 (III), director of NIST's Office of Standards Services. Greenfield was joining the U.S. Mission to the European Community (USEC) in Brussels to help the U.S. government and private-sector standards groups deal with standards issues in the European Community (EC). Greenfield is a former private-sector standards expert in the electronics, computer, and aerospace industries. As the U.S. technical standards analyst at the USEC Mission, he will report both to government and private-sector groups on standards-related developments within the EC and he will help advocate United States standards in Europe.

PHOTO: DONNA COVENEY/MIT NEWS OFFICE

ford in 1988, Jansen worked for several companies, including General Electric, Battelle Memorial, and Exxon Nuclear.... **Harvey G. Stenger**, ScD '84, has been named a full professor of chemical engineering at Lehigh University in Bethlehem, Pa. Stenger specializes in reaction engineering, materials processing, environmental concerns, and emission control. He joined the Lehigh faculty as an assistant professor of chemical engineering in 1984 and was promoted to associate professor in 1988. Stenger served as co-chair of the department of chemical engineering from 1989–91, and was appointed the director of Lehigh's Environmental Studies Center in 1991.... **John E. (Jack) Donahue**, '48, who retired from Hercules Inc., in 1989, has been given the Delano L. "Del" Boutin Division Service Award for "devoted service at the local division level," by the Paper Industry Management Association. Donahue has been a PIMA member since 1969 and worked with Del Boutin when he served as treasurer for the Northeast Division from 1975–89.

H.G. Stenger, Jr.

X-A PRACTICE SCHOOL

A year ago, basking in the joy of its 75th anniversary celebration on October 4 and 5, 1991, the School of Chemical Engineering Practice sent a newsletter to all its alumni/ae. This year we're trying a different experiment—a regular column of X-A and (and X-B) news in *Technology Review*. The experiment will be deemed a success if we have enough response from its intended readers to keep the column busy and newsy: write to us (the address is at the end of the column) about where you are, what you're doing, how you think of the Practice School—and what you see of other X-A (and X-B) folks. If you've a favorite photo, send it along, too.

After finishing at MIT, **Bernhardt Trout**, '90, SM '90, spent a year at the Sorbonne in Paris, then returned for work on a doctorate at the University of California at Berkeley; his thesis will be on the use of microprocessors for integrating chemical process sensors and actuators.... **Ernest O. Ohsol**, ScD '39, writes from Crosby, Tex., that he is working on "a pollution-abatement device for the petroleum industry" on which he's already obtained patents and some dfunding to start commercial development. "If it all works out," he writes optimistically, "I'll be able to contribute more to MIT."

Here's an invitation from **Enoch Chao**, SM '76, in New York; he's a VP for investment banking at the Bank of Tokyo: "I specialize in technology-related mergers and acquisitions opportunities," he writes; "I'm very interested in working with U.S. companies having proprietary technology and/or know-how who want strategic alliances, joint ventures, etc., with Japanese companies." Call him at (212) 766-3512.

Jeffrey Feerer, who was director at the Midland and Golden (Colo.) Stations before coming associate director of the Practice School in Cambridge in 1989, is now a senior environmental specialist at Dow Chemical Co. Maybe he missed those cold Midland winters, but in fact he's enthusiastic about his new job—on call throughout Dow's production areas to help minimize and manage hazardous wastes. Jeff's MIT desk remains empty, his former duties shared by Professor **T. Alan Hatton**, director, and **Robert C. Morrow**, the Department's administrative officer.... The School began 1992–93 with stations at Dow Chemical and Merck and Co.'s pharmaceutical operations at West Point, Pa. At the Midland Station, students work on one problem at Dow and one, typically in plastics, at neighboring Dow-Corning; the problems at West Point are generally in biotechnology. Fourteen stu-

The 1992 School of Science prizes for superlative performance in undergraduate teaching were presented to (from left): Richard C. Mulligan, '76 (VII), of biology, John G. King, '50, PhD '53 (VIII), of physics, and David E. Houseman of biology, shown being congratulated by Dean of Science Robert Birgeneau. They were cited for their skill in teaching laboratory subjects. Most recently, King is credited with handing out "brown-bag" lab kits in his introductory science classes, allowing beginning students to garner lab experience alongside lecture work in spite of limited lab space. According to Gene Brown, head of the School of Science teaching-prize committee, Mulligan and Houseman are credited with the "most effective teaching in the Biology Department." Each year, they assign overall lab themes, within which students select their own research projects. Each week students get together in class and critique each others' work, giving them experience working in teams to conduct hands-on research, an early exposure to graduate-level work.

PHOTO: DONNA COVENEY/MIT NEWSOFFICE

dents in the five-year SB/SM program will attend the School this spring or summer; and as many as 24 doctoral students will be candidates to attend in the summer or fall—a big crowd. The Practice School is recommended for almost all PhD/ScD candidates in chemical engineering; and two-thirds typically attend—about half of the total Practice School enrollment.

Most readers will remember that when I began the project that resulted in the history of the Practice School published early in 1992 (plug: copies still available at $20, plus $2 shipping charge; write Carol Phillips, Room 66-309, or call her at (617) 253-6600), I asked all alumni/ae for anecdotes and comments. They were wonderful; many appear in the book—along with some intriguing photographs that you sent. But some of your comments and stories, worthy of record, didn't for whatever reason make it into *The Flagship*. Here are a couple; more in future columns.

Edgar R. Pettebone, '36 (X-B), SM '37 (XIV), wrote from Terre Haute, Ind., about how he put his Practice School experience to work: "After six years with Esso and 26 years in the Navy (from which he retired as captain), I was invited to join the faculty at Indiana State University. The president offered me three different opportunities, one of which was to start a work-study program. That, by law, is a financial aid program; but he wanted academically oriented work experience that would make the classroom more meaningful. So we left 'work study' to the financial aid people and started a cooperative professional practice program; it worked well in the technology areas, business (especially accounting), the sciences, and even some liberal arts areas (economics)."

From his retirement home in Winter Haven, Fla., (he now has a Peoria, Ill., address), **Frederick C. Eaton, Jr.**, SM '31, recalls that he talked with the crew of a tanker unloading oil at the Eastern paper mill in Bangor, Me., in the winter of 1930. The oil, he learned, came from a new Esso refinery on the Caribbean island of Aruba. "Little did I think," recalls Fred, "that I would spend 29 years at that refinery."

Finally a request for help. While I was writing the Practice School history, several alumni told me to be sure to find the report, written in the best Practice School style and format, of a snipe hunt organized for the benefit of some uninitiated colleagues at the Bangor Station about 1930. No one with whom I consulted could find a copy of the report, and none could be turned up in Cambridge. **Roy P. Whitney**, '35, SM '36, ScD '45, for one, wrote from Appleton, Wis., that "I was sure I had a copy, but I have searched high and low and come up empty-handed." According to everyone's memory, it is a story worth retelling; if any reader has a copy, please loan it to us.—John Mattill, *Technology Review*, MIT, W59-200, Cambridge, MA 02139.

XI URBAN STUDIES AND PLANNING

Phillip L. Clay, PhD '75, has been named Course XI department head. Clay has been the department's associate head for two years and was also the director of the master's in city planning program. Clay is widely known for his work in housing policy and community-based development and employment. He has been involved in several studies that have received national attention. In a 1987 study commissioned by the Neighborhood Reinvestment Corp., a federal agency, he identified the institutional conditions contributing to the erosion of low-income housing and documented the need for a national preservation policy. He later served on the national commission that recommended the policy that became part of the Housing Act of 1990. He is a member of the policy research advisory councils of the Federal National Mortgage Association (Fannie Mae), the nation's largest investor in home mortgages. Among other works, his publications include two books, *Neighborhood Renewal: Middle-Class Resettlement* and *Incumbent Upgrading in American Neighborhoods and Neighborhood Politics and Planning*. . . . **Samuel J. Cullers**, MCP '52, president of Samuel J. Cullers & Associates in Sacramento, Calif., sends word about Lambda Alpha International. Cullers, treasurer of the honorary land economics society's Sacramento Chapter, was among a group that heard a talk entitled "America on the Ropes—the 1990's and Individual and Economic Freedom" a description of recent developments in the law regarding land use and eonomics. . . . **Irene D. Jenkins**, SM '89, has been named director of development at the Vermont Housing Finance Agency in Burlington, Vt. Previously, she was housing development coordinator at the Rhode Island Housing & Mortgage Finance Co. in Providence, R.I.

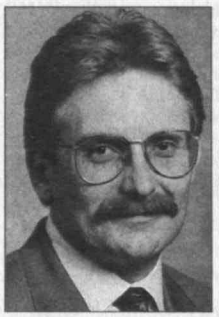
P.L. Clay

XII EARTH, ATMOSPHERIC, AND PLANETARY SCIENCES

Paul J. Roebber, SM '83, was erroneously listed as deceased in the October 1992 Course XII column. *Technology Review* heartily apologizes for the mistake. Roebber, is very much alive and well and living in Albany, N.Y. After leaving MIT, from 1983–88, Roebber worked at Metereology & Environmental Planning Limited, a Toronto-based consulting company. In the fall of 1988 he entered a PhD program at McGill, his undergraduate alma mater. This past June, after earning a PhD in meterology, he started post-doctoral studies with **Lance Bosart**, '64 (XVI), SM '66, PhD '69, in the Department of Atmospheric Science at SUNY Albany. His research is focused on physical processes in cyclogenesis, the development of winter time storms. He and Kathleen have a nine-month-old son, Kevin. He says, "We like Albany, but it's definitely not paradise!"

Donald J. Weidner, PhD '72, a professor at the State University of New York at Stony Brook, is one of three authors of a paper recently published in *Science*, the weekly journal of the AAAS. The paper, titled "Elasticity of Cristobalite: A Silicon Dioxide with a Negative Poisson's Ratio," takes a look at data obtained from compression of this naturally forming crystalline structure. The authors are members of the university's Department of Earth and Space Sciences and the Center for High Pressure research located at the department.

Donald L. Paul, '67 (XVIII), SM '69, PhD '77, has been named president of the newly created Chevron Petroleum Technology Co., based in Houston, Tex. When Paul was asked to give a talk last year to a group of oil exploration scientists, he cobbled together some thoughts he had saved through the years in a speech on the future of oil industry research. His speech turned out to be a rough blueprint for this new subsidiary of the Chevron Corp. that he has been tapped to lead, a combination of five oil and gas research and technology units. The merged unit has 1,100 employees, and represents a step in Chevron's two-year-old restructuring, and is expected to save $60 million annually in operating costs.



D.L. Paul

Philip H. Lord, Jr., '43, of Punta Gorda, Fla., died

on August 2, 1992. For 34 years, Lord worked for the National Oceanic and Atmospheric Administration at its Portland, Me., weather bureau. He was a member of the Falmouth, Me. planning board, volunteer fire department, and was a trustee of the memorial library. He was an active member of the Audubon Society and the League of Women Voters of Charlotte County. He was also a member of the Isles Yacht Club and the Punta Gorda Sailing Club.

XIII OCEAN ENGINEERING

Daniel J. Peters, SM '89 (III), NE '89, is currently participating in two major maritime exercises aboard the aircraft carrier USS *Kitty Hawk*, homeported in San Diego, Calif. The five-nation exercises, RIMPAC (Rim of the Pacific) '92, and Tandem Thrust include sailors, airmen, Marines, soldiers, and Coast Guardsmen from Canada, Australia, the Republic of Korea, Japan, and the United States. RIMPAC's training operations are conducted at sea between Southern California and Hawaii while Tandem Thrust's operations are conducted at sea off the coast of California and ashore in Southern California and Arizona. Peters is involved in a series of joint task-force exercises that include more than 60 ships and submarines, 400 aircraft, and more than 40,000 personnel.

David Nowak, SM '74, of Dunstable, Mass., died on July 27, 1992. Nowak worked at Microwave Logic, Inc., in Tyngsboro, Mass. He was previously employed by Electric Boat Co. in Groton, Conn., the RCA Corp. in Burlington, Mass., and Sanders Associates in Nashua, N.H. He coached youth soccer and baseball in Dunstable.

Captain **Thomas L. Albee, Jr.**, SM '60, NE '60, USN (ret.), of Fairfax, Va., died on July 29, 1992. Albee served 25 years in the Navy, and retired as head of Navy ship systems and design and engineering at the Naval Ship Engineering Center in Washington, D.C. He was an executive with TRW in Virginia, working on naval systems. Albee was a lifetime member of the U.S. Naval Academy Foundation and he was a volunteer in several community organizations. He had been a summer resident of Wellfleet, Mass., since 1964 and planned to retire there in September.

Rear Admiral **Charles J. Palmer**, SM '37, USN (ret.), of East Sandwich, Mass., died on July 26, 1992. Palmer served in various posts connected with the design, construction, and repair of naval vessels and associated R&D until his retirement in 1964 as a rear admiral (engineering duty). His last two assignments on active duty were as commander of the Long Beach Naval Shipyard in Long Beach, Calif., and as commander of the Portsmouth Naval Shipyard in Portsmouth, N.H. He received the Order of the Southern Cross from the Brazilian government for assistance in the design of destroyers and the U.S. Bronze Star for work in connection with battle-damage repair and maintenance of U.S. naval vessels in the South Pacific area during WWII. At the time of his second retirement in 1970, he was serving as director of engineering of General Dynamics' Quincy Shipbuilding Division. He was a member of the Society of Naval Architects and Marine Engineers.

The Association of Alumni and Alumnae has been notified that **Immo-Ragnar H. Nordstrom**, '60, of Fair Haven, N.J., died on April 27, 1992. No further information was provided.

XIV ECONOMICS

Professor of Finance **David Modest**, '76, PhD '81, , has received the 1992 U.C. Berkeley Distinguished Teaching Award, the campus' highest teaching honor. Long known around Berkeley for his effective if sometimes unorthodox instructional methods, Modest previously received the Haas School's

D.M. Modest

Cheit Teaching Award for 1990–91. He is the seventh Haas School teacher to win the university-wide prize. As described in a *California Monthly* magazine article last year, to help students keep their minds on financial matters, Modest throws money—in small denominations—around the room. He invites students to join him in the "Covariance Dance"—a variation on the Chubby Checker twist that also demonstrates an important statistical concept. To illustrate commodities trading, he may nonchalantly lift the notebook from a student's desk—and sell it to someone else. Modest started his teaching career at Columbia's business school. In 1987 he joined the Berkeley faculty and was promoted to associate professor in 1989. He has chaired the MBA finance group since 1990. Modest's research emphasizes empirical tests of asset pricing models, global portfolio management, and futures and options markets. He credits **Robert Solow** as his teaching role model and one of the professors who had the greatest impact on his life.

XV MANAGEMENT

From West Hatfield, Mass., **Carol Cedrone Brennan**, SM '84, writes: "I have been an 'at-home' mother since the birth of Alexander (February 13, 1990), although I have worked occasionally on a consulting basis. Things have become more hectic with the birth of Madeleine on March 24, 1992! Chris and I really enjoy living in Western Massachusetts."

Sylvia Steinmann, SM '91, sends word from Berlin, Germany, where she is a senior associate with McKinsey: "McKinsey is keeping me pretty busy. I went back to Cambridge for the CISR Summer Seminar '92 and met again other Sloanies (**Jessica Toth**, SM '91, **Paul O'Malley**, SM '91, and **Amey Moot**, SM '91). It felt great to be back. Momentarily I am surveying the European Money Transfer market. Lots of people, lots of fun, but also lots of logistics. Special greetings to **Charlie W. Tillett**, SM '91. Thanks for your letters." . . . **John F. Fort III**, SM '66, has retired as chair of Tyco Labs, Inc., in Exeter, N.H. He continues with Tyco as a member of their board of directors.

Susan D. Lewtan, SM '76, recently married Glenn Langberg in a West Hartford, Conn. wedding. Lewtan is a securities analyst at Bear, Stearns & Co., in New York City.

Maryann P. Burke, SM '80, has been named chief operating officer of group operations at Liberty Life Assurance Co. in Dover, N.H. He was formerly senior VP of Liberty Mutual Insurance Holding Co. in Boston. . . . **Arthur L. Keigler II**, SM '83 (III), SM '92 (II), SM '92, writes: "I jumped into my job at Digital Equipment Corp. (manufacturing engineering manager) two weeks before graduation. Ever since, I've been busy applying all sorts of things I learned at Sloan—they already call me 'the Post-It man'; thanks Shoji. Gabriele and I are looking forward to five weeks of trekking in Nepal this fall. The question is: Can I go from high tech to high peaks and back to high tech?" . . . **Adrienne E. Weiss**, SM '92, writes: "Allen and I had a great month in Hawaii and Colorado: whitewater rafting, snorkeling, hiking, sea kayaking along the NaPali Coast. It was tough coming back to reality. I started at Fidelity at the end of July, working as product manager for brokerage. It's been great so far. Look out for some direct mail coming your way: anyone want to open a Fidelity Plus brokerage account?" . . . In the October 1992 issue of *Technology Review* an error crept into the Course XV col-

umn. **Susan Reilly Cerrone**, SM '83, has been independently contracting to hospitals and is the acting *CIO* for the Boston University Medical Center, not acting CEO as we had reported.

Sloan Fellows

Dennis J. Volpe, SM '90, has been named international program director at Electronic Systems Division. This program is responsible for acquisition of command, control, and communications systems for foreign governments. Diverse systems, from air defense radars to digital encryption devices, are being provided to Thailand, Egypt, Canada, United Arab Emirates, Colombia, Japan, and Israel. Additionally, the program office is supporting recent Air Force initiatives to provide technical advice and assistance to former Warsaw Pact countries. Volpe, who began his career with the federal government in 1969, has been deputy director of international programs for six years. His past assignments at ESD include chief engineer for strategic systems and program director for North American defense programs. He is the first civilian to hold his position. . . . **William L. Bucknall, Jr.**, SM '80, has been elected senior VP for human resources and organization at United Technologies Corp. in Hartford, Conn. Bucknall has been with UTC 26 years, first in a series of human resources positions with Pratt & Whitney, followed by a succession of executive assignments at Otis, corporate headquarters, and Carrier. He had served for two years as UTC VP for human resources and organization prior to his promotion. Bucknall serves on the National Corporate Committee for the United Negro College Fund.

W.L. Bucknall, Jr.

F. Duane Ackerman, SM '78, chair of Bell South Services Co. in Atlanta, Ga., has been elected to the board of directors at the Jacksonville, Fla.-based American Heritage Life Insurance Co.

Richard J. Santagati, SM '79, has been named president and CEO of Artel Communications Corp. in Hudson, Mass. Previously, Santagati was a partner at Lighthouse Capital Management, Inc., in Boston. . . . Last October, **James G. Kaiser**, SM '73, assumed the dual role of president and CEO of Enseco, Inc., in Denver. He left the Corning, N.Y.-based Corning, Inc., as VP and general manager of the Technical Products Division. He has also recently been named to the board of directors at Stanley Works in New Britain, Conn.

William C. Ford, Jr., SM '84, has a new title at Ford Motor Co. in Dearborn, Mich. Ford, who was manager of strategic planning, has been named general manager of the Climate Control Division.

James Hawes III, SM '88, VP and CEO-Nebraska at U.S. West Communications in the state of Nebraska, delivered the commencement address at Elbert County Comprehensive High School in Athens, Ga. Hawes joined Northest Bell in 1984 as manager of strategic planning and has held various positions since that time.

Senior Executives

Andrew C. Knowles, '76, has retired as president and CEO at Artel Communications Corp. in Hudson, Mass. Knowles continues to hold a seat on Artel's board of directors.

Peter C. Haeffner, Jr., '72, president of Sonnenblich-Goldman Corp. in New York City, has been elected to the Greater New York Savings Bank's board of directors.

Learning From Experience With the Japanese

To Americans, the culture, the people, and the language of Japan seem almost impenetrable. From individual employees to the highest government officials, the U.S. stance in interactions with the Japanese often ends up at the same point: You're being unfair—for expecting unlimited overtime without pay, for stringing our company along and not letting us know where we stand, for insisting on licensing agreements but refusing to do any real trade with U.S. companies.

It's a charge that Japanese people find bewildering, and it's the place at which many business negotiations become stalled. In Japan, relationships, especially business relationships, are built slowly, over time, according to highly structured rules designed to build trust and test commitment, explains Patricia Gercik in her recent *On Track with the Japanese: A Case-by-Case Approach to Building Successful Relationships* (MIT Press, 1992). By contrast, in the United States, businesspeople prefer to get to the point and make deals quickly, and they don't hesitate to switch suppliers or even file a lawsuit if things don't work out.

Gercik is the managing director of the MIT/Japan Program, which oversees placement of MIT graduates in Japanese companies, research laboratories, and (less often) graduate programs, and it also organizes a variety of activities on campus designed to promote cross-cultural understanding. While the book was inspired by experiences of the program participants, the cases are not limited to MIT graduates.

Through the telling of 23 short, problem-solving case studies, Gercik offers access to a world that many *gaijin* assume is closed to them precisely because they are foreigners. She explains the importance of personal behavior—punctuality, seating arrangements, humility, gift giving, guest etiquette—and also details how companies are structured and how networks are built among universities, government, and industry through the routine use of go-betweens and mentors. By working with the system and reserving judgment, she asserts, Americans can and do find their way to the inner circles of Japanese business.

Two Japanese concepts that Americans often find hard to understand are creating obligation (*on giri*) and saving face (*kao*).

Gercik tells the story of Mary, an American woman working as a writer and editor for a Japanese government agency. After her first week on the job, her boss, Yamada, calls her at home on the weekend, asking for help because his window won't open. Not sure what to do, Mary offers to call his landlady. Several more such requests follow, and Mary obliges. Whereas an employee in the United States would likely be outraged, Mary realizes that, to the Japanese, her willingness to go beyond her professional duties shows her commitment to her work and also her solidarity with her boss.

"Small personal favors incur obligation on both sides," Gercik writes. "There is a correlation between the amount of trust invested in an employee and that employee's willingness to go beyond the letter of his or her contract." Later, when Mary asks Yamada for a pay raise and an extended vacation to visit her ill mother, he shows his trust in her by telling her to take as much time as she wants.

The book does not limit itself to relationships that take place in Japan. In another case, Edwards, a British scientist, has taken on three young Japanese researchers in his laboratory. Two are wonderful to work with, but the third, Yabe, does sloppy work and even sets the lab on fire—albeit accidentally.

When Edwards contacts the personnel department about sending Yabe back to Japan, the other two insist they must quit, too. "If he goes back, it will bring shame on all of us," one says. Because of their loyalty to the group, the two offer to take care of their colleague. Eventually, though, they realize he is also a liar and devise a scheme whereby his grant money is terminated, so he will not have to lose face. "In Japanese society," Gercik explains, "expulsion is more upsetting than any other punishment and is to be avoided at all costs."

With its easy-to-read narratives and insightful analysis, *On Track with the Japanese* is a practical crash course for anyone studying or doing business in Japan or working closely with Japanese at home.

—*Kimberly French* □

Management of Technology Program

Anita Kirkpatrick, SM '85, passed the California Bar in 1991 and has been an associate patent attorney at Knobbe, Martens, Olson & Beal sience then. . . . **Richard Norton**, SM '85 (I), is project manager at Griener, Inc., in Santa Ana, Calif. . . . **Kee-Joo Tan**, SM '88, is now division manager of the Business Sales Division at Singapore Telecommunications. He is responsible for the sales and marketing of telecommunication services to all business customers in Singapore. . . . **Jean-Pierre Rogala**, SM '90, is director of marketing for Apic Systems in France. . . . **Kip Steveley**, SM '90, is chief engineer of the Powertrain and Aerospace Division at Delco Moraine, a division of GM in Dayton, Ohio. . . . **Hajime Yamada**, SM '90, was promoted to executive manager of the department of New-Technology-Related Businesses of the NTT affiliated business development headquarters in Tokyo. . . . **Roberta Lynne Zald**, SM '90, is marketing planning manager at GM Fanuc Robotics Corp. . . . **Mikihiko Kato**, SM '91, is chief engineer at the R&D Center in the Magneto Products Division of Fuji Photo in Japan. . . . **Naoki Kato**, SM '91, is senior manager in the Research Planning Department at NTT LSI Laboratory in Tokyo. . . . **Koichi Hagishima**, SM '92, is manager of engineering strategy in the Technology Research Department of General Planning Headquarters at NTT. . . . **Sasi Kumar Pillay**, SM '92, is now deputy branch chief of the Mainframe Systems Computer Services Division at NASA Lewis Research Center in Cleveland, Ohio. . . . **Toshihiko Shoyama**, SM '92, is a visiting fellow at the Sloan School this year. Toshi and his wife, Yukiko, spent the summer of 1992 traveling around the United States and Canada. Their favorite spot was Yellowstone National Park.—Fay Wallstrom, Management of Technology Program, MIT, Room E56-304, Cambridge, MA 02139.

XVI AERONAUTICS AND ASTRONAUTICS

Holt Ashley, SM '48, ScD '51, professor emeritus of aeronautics and astronautics and mechanical engineering at Stanford University, has received the Spirit of St. Louis Medal of ASME. The medal was established in 1929 by Philip D. Ball, ASME members, and citizens of St. Louis. It is awarded annually for meritorious service in the advancement of aeronautics and astronautics. Ashley was cited for "pioneering contributions to aeroelasticity and their enormous influence on the research, education, and engineering practice in aircraft design and for leadership in numerous Air Force and NASA R&D tasks." Ashley left MIT to begin his career at Stanford in 1967 and has remained there since, except for brief periods at other institutions. He has written or edited six books and many archive publications. He has served many years on various NASA committees and the U.S. Air Force Scientific Advisory Board. Elected to the NAE in 1970, he served six years on its council and three on the National Research Council Governing Board. After holding several other offices, he was elected president of the AIAA in 1973.

John N. Rossettos, '55, SM '56, professor of mechanical engineering at Northeastern University in Boston, has been named a Fellow of ASME. His major contribution is in analysis of thin shells and membranes: toroidal, cylindrical, and spherical shells, and membranes of revolution (deep and shallow). His work has been used and referenced many times by researchers in the field. Other major contributions concern stability and vibration of plates and beams, crash-worthiness, and adhesive joints. Rossettos has been a member of ASME since 1967. . . . Wilma and **Philippe Kletzkine**, SM '83, announce the birth of their son Jonathan Simon on July 26, 1992.

XVII POLITICAL SCIENCE

From Nashua, N.H., **Raymond Grenier**, SM '71, writes: "I accepted early retirement from Digital Equipment Corp. and joined with George Metes to form Grenier & Metes Associates. We offer consulting services based on our recently published book, *Enterprise Networking: Working Together Apart* (Digital Press). We focus on the design and facilitation of distributed teams using networking technology and techniques to effect necessary lines. We can be reached at 603-882-7644." . . . *The Highest Stakes: The Economic Foundations of the Next Security System* (Oxford University Press, 1992), has recently been published by the members of the Berkeley Roundtable on the International Economy (BRIE), at the University of California at Berkeley. **John Zysman**, PhD '74, is one member in the group of seven involved in the project. According to a blurb on its jacket, the book "explores how the momentous dislocations of economic power in the world—the burgeoning might of Asia, the unification of Europe, the relative decline of the United States—will reshape global security issues. Representing over six years of research by seven scholars, this timely analysis also goes beyond the discussion of America's decline to examine how the emergence of regional trading blocs may carve out new international security arrangements."

XVIII MATHEMATICS

From Bethesda, Md., **Howard W. Kreiner**, SM '54, writes: "In August, the Operations Research Society of America published my book, *Fields of Operations Research*. The book describes analyses I did of naval operations while working with the U.S. Navy in the field and at sea through its operations evaluation group and the Center for Naval Analyses between 1951–89." . . . **Leopold Flatto**, PhD '55, sends word from New York City: "I have been at the Mathematics Center at Bell Laboratories since 1979. In addition, I am an adjunct professor at Yeshiva University since 1986. . . . **Eric Reissner**, PhD '38, has been elected an honorary member of Germany's Society for Applied Mathematics and Mechanics (GAMM). This is only the seventh such election in the Society's history. Reissner writes: "It's a strange feeling to share this recognition with such luminaries as the engineers Stodola, Prandtl, and von Karman, and the mathematicians Felix Klein, Görtler, and Collatz."

XX APPLIED BIOLOGICAL SCIENCES

Larry R. Brown, ScD '83, has been appointed director of formulation development at Arcturus Pharmaceutical Corp. in Cambridge. A biotechnology company, Arcturus develops and commercializes novel products for dermatological disorders based on advances in skin biology as well as technology for enhancing the delivery of therapeutic compounds into the skin. Brown has extensive experience in polymer-based and transdermal drug delivery systems and has held senior R&D positions with Enzytech, Harbor Medical Devices, and Moleculon. . . . **John N. Udall, Jr.**, PhD '80, has been appointed professor and director of the Gastroenterology and Nutrition Section of the Department of Pediatrics at Louisina State University's Medical Center. He has also been named chief of the section of Gastroenterology and Nutrition at Children's Hospital in New Orleans. Udall has held academic positions at MIT's Clinical Research Center, Harvard Medical School, the Shriners Burn Institute, and most recently, as associate professor of pediatrics at the University of Arizona College of Medicine. Since 1980, Udall has served on 28 different nutrition and pediatrics committees in the United States and abroad.

XXII NUCLEAR ENGINEERING

Eduardo Testart, SM '81, sends a letter from Chile where he is the director of projects and liaison with the private sector at the Universidad de Valparaíso. He helps maximize the probability that university researchers will get support for their projects by receiving basic and applied research funds. He is also establishing cooperation agreements with other universities, institutions, and private companies. He says, "I am very happy in this new position, but the amount of work is terrible. We have approximately 8,000 students and 400 professors. We have five faculties (Architecture & Construction, Law & Social Science, Medicine, Odontology, and Economic & Administrative Sciences), three institutes, and 18 schools." He observes that the university and the region (oceanside with 1.5 million inhabitants) has been depressed for a long time. He wants to help change this situation within 3–5 years. Testart is working on projects such as donation of equipment, interchange of professors and researchers, joint ventures, and foreign investments. He is also working on the establishment of an "Entrepreneur Incubator" as well as a technological park. He writes, "My family is renting a large house in Viña and of course my colleagues and classmates have their own room waiting..." He can be reached at (032)662974.

Daniel R. Wilkins, SM '63, ScD '66, general manager of the Nuclear Services and Projects Department at General Electric in San Jose, Calif., has received the George Westinghouse Gold Medal from the American Society of Mechanical Engineers. Wilkins was cited for "25 years of distinguished contributions to the design, development, and construction of nuclear power plants, especially boiling-water reactors; and for demonstrated leadership in providing a vision and firm path for the development of the next generation of nuclear power plants in this era of standardization, enhanced safety, and increasing globalization of the power industry." In his 25 years with GE, he has held positions in direct energy conservation, breeder reactor development, nuclear fuel development, quality assurance, and reliability engineering.... **Robert E. Donovan**, SM '68, has been named president at Asea Brown Boveri, Inc., in Stamford, Conn. He was formerly VP and group executive at Foster Wheeler Corp. in Clinton, N.J.

TPP TECHNOLOGY AND POLICY PROGRAM

Professor **Richard de Neufville** spent one week in Seattle, Wash., advising the Washington State Air Transport Commission on their long-range strategic plans.... **Simon Stokes**, SM '88, is now qualified as a solicitor and has taken a job with McKenna and Co. in London.... **Ellen Banaghan**, SM '91 (XV), SM '91, is planning a wedding to be held on July 10, 1993. Congratulations!... **M.B. "Tunde" Eafunwa**, SM '92 (XV), SM '92, has joined the staff of Bell Atlantic in Arlington, Va., as manager of third-party development.... **Steve Schondorf**, '88, SM '92 (XVI), SM '92, is now working at Ford. Also, rumor has it Steve is getting married.—Richard de Neufville, Technology and Policy Program, MIT, Room E40-252, Cambridge, MA 02139

STS PROGRAM IN SCIENCE, TECHNOLOGY & SOCIETY

Michael M.J. Fischer has been appointed jointly as a professor in STS and Anthropology. He begins his appointment in Janaury 1993. Fischer received master's and PhD degrees from the University of Chicago in anthropology. He did his undergraduate work at The Johns Hopkins University. A major contributor to Middle Eastern studies, his current research concerns the anthropology of science, with a focus on modern science and technology. Fischer taught at Rice University from 1988–92, where he also served as director of the Center for Cultural Studies. He has been a senior fellow at the Smithsonian Institution (1990) and received numerous grants and fellowships, including a Rockefeller Postdoctoral Fellowship Residency Site Grant for the Rice Center (1989). His publications include: "Anthropology as Cultural Critique—Inserts for the 1990s: Cultural Studies of Science, Visual-Virtual Realities, and Post-trauma Politics" in *Cultural Anthropology* in 1991.... **Deborah Fitzgerald** was selected as the Class of 1956 Career Development Professor at the Institute. She will hold the chair for a term of three years. Fitzgerald was also awarded the 1992 Graduate Student Council Teaching Award for the Humanities.—Graham Ramsay, STS Program, MIT, Room E51-128, Cambridge, MA 02139

Deceased

The following deaths have been reported to the Alumni/ae Association since the *Review* last went to press:

Wayland S. Baily, '19, SB '24; September 4, 1992; Norwell, Mass.
Stanley B. Bragdon, '20; August 19, 1992; Lewiston, Me.
Oliver H. Coolidge, '21; January 17, 1992; Center Sandwich, N.H.
Harvey E. Brown, '22, SM '23; August 17, 1992; Montclair, N.J.
Roland N. Black, '24; August 3, 1992; Richmond, Va.
James I. Metcalf, '24; August 11, 1992; Seattle, Wash.
Arthur W. Larchar, '25; June 13, 1992; Hockessin, Del.
Temple C. Patton, '25, SM '32; July 1, 1992; Bricktown, N.J.
Richard A. Butler, '26; August 10, 1992
Cyril S. Smith, ScD '26; August 25, 1992; Cambridge, Mass.
Emily May Bixby, SM '27; August 19, 1992; Methuen, Mass.
Bidermann T. du Pont, '27; August 26, 1992; Wilmington, Del.
Ogden Fitzsimons, '27; SM '29; June 11, 1992; Kimberton, Pa.
Roger R. Smith, '27; September 10, 1992; Concord, N.H.
David P. Moore, '28; May 18, 1992; Canton, Ohio
Henry A. Schade, SM '28; August 12, 1992; Kensington, Calif.
James L. Cutler, Jr., '29 GE; August 1, 1992; Cuyahoga Falls, Ohio
Harold A.C. Dahl, '29; August 13, 1992; Westford, Vt.
Jackson H. Emery, '29; August 2, 1992; Norristown, Pa.
Hyman J. Fine, '29; May 28, 1992; Norfolk, Va.
John T. Harrison, '31; August 29, 1992; Durham, N.H.
William Nixon, SM '31; July 31, 1992; Hertford, N.C.
Charles E. Starr, Jr., '31; July 12, 1992; New York, N.Y.
Robert H. Bayer, '33; July 30, 1992; Toledo, Ohio
Dorothea L. Hagan, '33; September 9, 1992; Scottsdale, Ariz.
Edward E. Pierce, Jr., '34; September 1, 1992; Newton Square, Pa.
Merton O. Baker, '36; August 9, 1992; Wakefield, Mass.
Charles F. Kennedy, '36; May 1, 1991; Elmira, N.Y.
David E. Varner, '36; August 24, 1992; Bethesda, Md.
Edna M. Cree, '37, MPH '48; June 26, 1992; Middleton, Wis.
Ormond Barstow, ScD '38; July 25, 1992; Midland, Mich.
Joseph E. D'Angelo, '38; January 1991; Albuquerque, N.M.
Clifford V. Nelson, '38; September 21, 1992; Gorham, Me.
William R. Downs, PhD '39; June 22, 1992; Louisville, Ky.
James F. Healey, '41, SM '48; August 29, 1992; St. Petersburg, Fla.
Hamilton Johnson, '41; June 16, 1992; Grand Rapids, Mich.
William D. Robertson, '42, ScD '48; August 9, 1992; Charlottesville, Va.
Russell J. Bowen, '43, SM '47; August 9, 1992; Arlington, Va.
Philip H. Lord, Jr., '43; August 2, 1992; Punta Gorda, Fla.
William C. Engelmann, '44; June 21, 1992; Plymouth, N.Y.
John C. O'Shea, '45; March 11, 1992; Summit, N.J.
Melvin J. Deroche, '48; July 25, 1992; Portland, Me.
Bruce K. Gaviller, '48; June 30, 1992; Lockport, N.Y.
Robert L. Manz, '48; August 24, 1992; Peterborough, N.H.
Edward H. Kelly, Jr., '49; November 27, 1991; Fallbrook, Calif.
Davis B. Keniston, '49; August 24, 1992; Perkinsville, Vt.
Arthur C. Loven, '49; August 29, 1992; Medfield, Mass.
Frederick W. Griebel, Jr., '50; August 8, 1992; Lynnfield, Mass.
Norman Rudnick, SM '52; August 9, 1992; Philadelphia, Pa.
James H. Flanders, '53, SM '57; August 24, 1992; Cambridge, Mass.
Christopher R. Whitcombe, '53; July 26, 1992; Newark, Del.
Robert L. Coble, ScD '55; August 27, 1992; Arlington, Mass.
Robert C. Ernest, SM '59; August 6, 1992; Neenah, Wisc.
Thomas L. Albee, Jr., SM '60, NE '60; July 29, 1992; Fairfax, Va.
Etienne R. Aberth, SM '60; January 19, 1991; Yonkers, N.Y.
Edward J. Hronik, SM '66; August 26, 1992; Littleton, Mass.
George J. Duffy, '67; 1987; Medford, Mass.
David Nowak, SM '74; July 27, 1992; Dunstable, Mass.
Brandon L. Minor, SM '77; March 1, 1992; Tacoma, Wash.
Leslie A. Rippel, SM '78; August 27, 1992; Westport, Conn.

Bill + Jill ≠ Dill

This being the first issue of a calendar year, we again offer a "yearly problem" in which you are to express small integers in terms of the digits of the new year (1, 9, 9, and 3) and the arithmetic operators. The problem is formally stated in the "Problems" section, and the solution to the 1992 yearly problem is in the "Solutions" section.

Problems

Y1993. Form as many as possible of the integers from 1 to 100 using the digits 1, 9, 9, and 3 exactly once each and the operators +, -, x (multiplication), / (division), and exponentiation. We desire solutions containing the minimum number of operators; and, among solutions having a given number of operators, those using the digits in the order 1, 9, 9, and 3 are preferred. Parenthesis may be used for grouping; they do not count as operators. A leading minus sign *does* count as an operator.

JAN 1. Edward Wallner sent us the following problem from "the gamesman" column in *IEEE Potentials*, where it was credited to Cindy Furst. Ms. Furst claims that every electrical engineer should be able to fill in the four blanks:

10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, __, __, __, __, 100.

JAN 2. Temple Patton has a plot of land in the form of a right triangle with all sides an integral number of feet. If the short side is 30 feet, what is the area? What if the short side is 31 feet?

Speed Department

Donald Zalkin has some strange theory about reducing fractions. He cancels the 6s in 16/64 to get 1/4. How generally does this work? Specifically, what other fractions with numerators and denominators under 100 have this cancellation property?

SEND PROBLEMS, SOLUTIONS, AND COMMENTS TO ALLAN J. GOTTLIEB, '67, THE COURANT INSTITUTE, NEW YORK UNIVERSITY, 251 MERCER ST., NEW YORK, N.Y. 10012, OR TO: GOTTLIEB@NYU.EDU

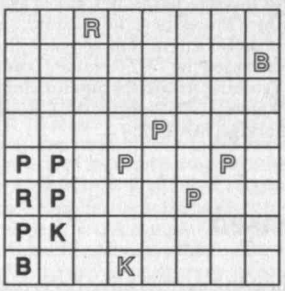
Solutions

Y1992. The following solution is from David Brahm, who points out that 1993 will be a better year (at least as far as our yearly problem is concerned). Eric Osman tried all four digit years and reports that for no year are all 100 values possible. The best possible, according to Eric, is 98 out of 100. But that won't happen again until 2347; it last occurred in 1983. I just checked my files and indeed we found 98 solutions.

1 = 1^992	28 = 29 - 1^9	69 = 9 * 9 - 12
2 = 1^99 * 2	29 = 19 * 2 - 9	70 = (1+9) * (9-2)
3 = 1^99 + 2	30 = 19 + 9 + 2	71 = 9^2 - 1 - 9
4 = 1 + 9/9 + 2	33 = 99 / (1+2)	72 = (1+9-2) * 9
5 = (19-9) / 2	34 = 2 * (9+9-1)	73 = 92 - 19
6 = 9 - 12 + 9	35 = 2 * (9+9) - 1	74 = 2 + 9 * (9-1)
7 = 1^9 * (9-2)	36 = 1 * (9+9) * 2	78 = 99 - 21
8 = 19 - 9 - 2	37 = 19 + 9 * 2	79 = 1 * 9 * 9 - 2
9 = 1^92 * 9	38 = 29 + 9 * 1	80 = 91 - 2 - 9
10 = 29 - 19	39 = 29 + 9 + 1	81 = 1^9 * 9^2
11 = 12 - 9/9	40 = (9*9 - 1) / 2	82 = 92 - 1 - 9
12 = 19 - 9 + 2	41 = (91-9) / 2	83 = 1 * 92 - 9
13 = 12 + 9/9	45 = (1+9) * 9 / 2	84 = 1 - 9 + 92
14 = (19+9) / 2	47 = 19 * 2 + 9	87 = 99 - 12
15 = 9 + 9 - 1 - 2	48 = 19 + 29	88 = (1+9) * 9 - 2
16 = 1 * (9+9-2)	49 = (99-1) / 2	89 = 9^2 - 1 + 9
17 = 1 + 9 + 9 - 2	50 = (1+99) / 2	90 = 1 * 9 + 9^2
18 = 1^9 * 9 * 2	54 = (1+2) * (9+9)	91 = 92 - 1^9
19 = 29 - 9 - 1	55 = (9-1)^2 - 9	92 = 1^9 * 92
20 = (19-9) * 2	56 = (19+9) * 2	93 = 1^9 + 92
21 = 29 - 9 + 1	57 = (2^9 + 1) / 9	96 = 99 - 1 - 2
22 = 21 + 9/9	60 = 9 * 9 - 21	97 = 1 * 99 - 2
25 = 2 * (9-1) + 9	62 = 91 - 29	98 = 1 + 99 - 2
26 = 19 + 9 - 2	63 = 1 * 9 * (9-2)	99 = 12 * 9 - 9
27 = (12-9) * 9	64 = 1 + 9 * (9-2)	100 = 19 + 9^2

A/S 1. Unfortunately, APR 1 was misprinted so that white and black pieces were indistinguishable. As a result we are offering it again but with the colors indicated as intended. We apologize for the error.

White is to move and mate in 12.



Apparently this is hard even when the white and black pieces are distinguishable. Only the proposer offered a solution.

1. B-Kt8	K-Kt8	7. R-B5	K-Kt8
2. R-B1ch	K-Kt7	8. R-B4ch	K-Kt7
3. R-B6	K-Kt8	9. R-K4	K-Kt8
4. B-R7ch	K-Kt7	10. R-K3ch	K-Kt7
5. R-Kt6	K-Kt8	11. R-Q3	K-Kt8
6. R-Kt5ch	K-Kt7	12. RxPmate	

A/S 2. A real cute one from Jan Davis, who writes:

The wife of a man who grew barley
Was also the sister of Charlie.
  Her Neighbour grew hay
  And was married to Ray,
And one of these girls was named Carly.

The girl who was married to Wayne
Lived next to the farm that grew grain.
  She liked to eat celery
  That was grown by Valerie,
And she weighed 80 pounds more than Jane.

The woman whose husband grew dill
Was never married to Bill
  When Jane married Benny
  And Ray married Jenny,
She went out drinking with Jill.

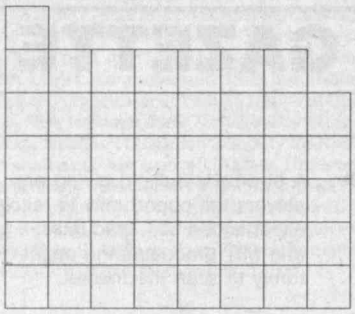
NOTE: ONLY ONE COUPLE HAS RHYMING NAMES.

My assistant, Nancy Cruz, remarks that preparing for the LSATs has finally had a tangible reward; her solution follows:

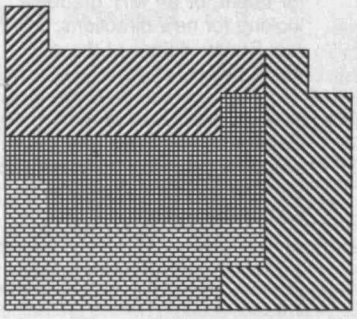
A	B	C	D	E
Bill	Wayne	Ray	Charlie	Benny
Jill	Carly	Jenny	Valerie	Jane
Grain	Barley	Hay	Celery	Dill

Both A and C are B's neighbors.
Celery-eating Carly is Charlie's sister.

A/S 3. Our last regular problem is "Golomb's Gambits" edited by Solomon Golomb in the *Johns Hopkins* magazine. You are to dissect the figure below into four congruent pieces.



A beautiful picture from Bill Mills:



Other Responders

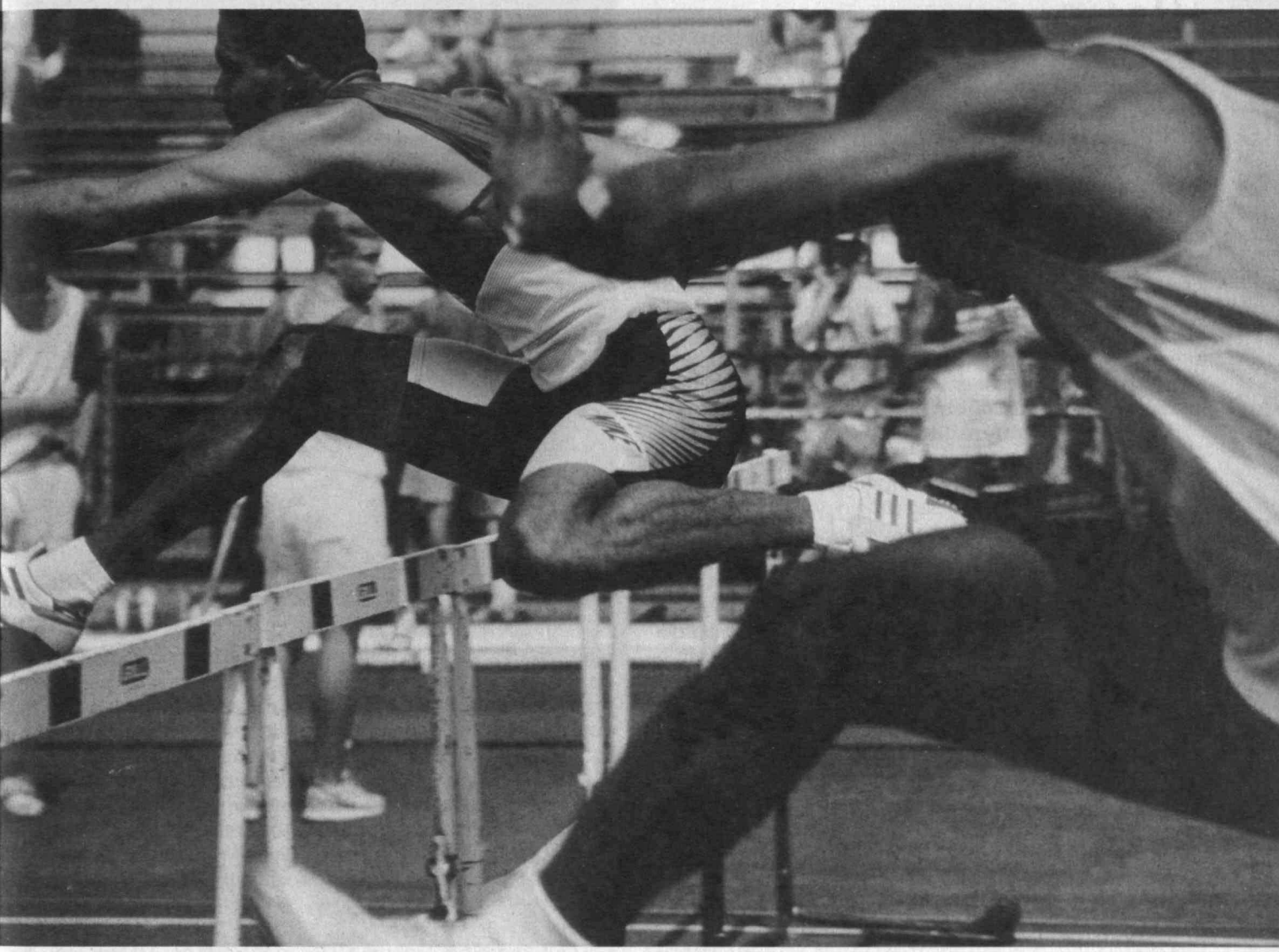
Responses have also been received from R. Bator, W. Cluett, C. Dale, J. Datesh, J. Drumheller, S. Feldman, M. Fountain, T. Gibson, W. Hartford, R. Hess, R. High, D. Hopkins, A. Katzenstein, E. Kim, M. Lindenberg, A. Lowenstein, E. Lund, T. Lydon, P. Oliveira, A. Ornstein, D. Plass, K. Rosato, A. Tracht, C. Whittle.

Proposer's Solution to Speed Problem

19/95, 49/98, and 26/65.

REPORT OF THE PRESIDENT

For the Academic Year 1991-92



"A slow sort of country!" said the Queen.
"Now here, you see, it takes all the running you can do,
to keep in the same place.
If you want to get somewhere else,
you must run at least twice as fast as that!"

Lewis Carroll
Through the Looking Glass

PHOTO: GREG ROGALSKI '92/TECHNIQUE

Excellence in an Era of Change and Constraint

America's research universities are faced with a central challenge — to retain and enhance excellence in a time of fiscal constraint and societal uncertainty. We are experiencing a deep sense of frustration because never in our history has the field of intellectual challenge and opportunity or the need for our services to the nation and the world been so great; yet never in recent decades have we experienced such fiscal constraint or sensed such a fall from grace with the public and the government. We are not in crisis, but we are in a precarious state, one that may be more difficult to grasp and respond to than crisis.

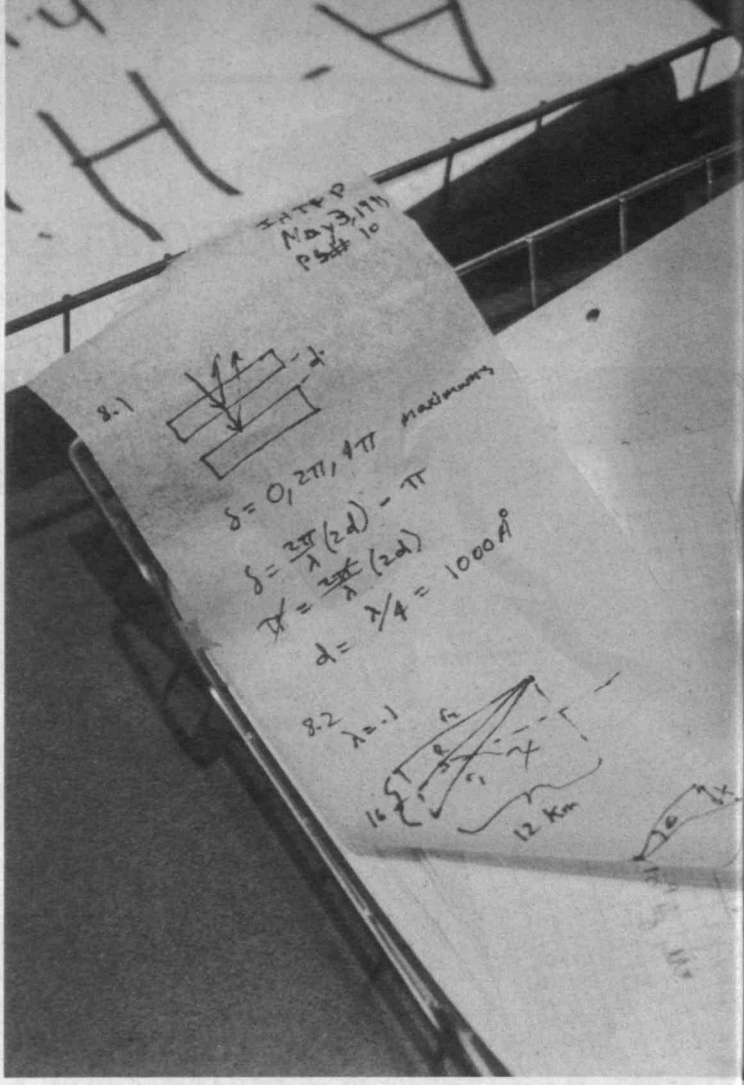
But respond we must, because this is a time in which we at MIT and our colleagues around the country should solidify and expand our roles as leaders in this increasingly complex world. We must define new disciplinary futures and invent new intellectual pathways to understanding the physical, biological, economic, and artistic universes. It is a time in which we must do our part in shaping the future.

The challenges before us are great. We must:

- continue to lead the revolution in molecular biology and advance the promise of biotechnology;
- come to understand the workings of the human brain and the nature of intelligence;
- bring the highest quality of mind to assessing and ameliorating humankind's effects on the earth's environment;
- secure the advances of computers, communications technology, and the information marketplace for the social good;
- better understand organizations and businesses and how to make them more effective in building vital and sustainable economies;
- combine the aesthetic and the technical in the design of the physical environment and in the creation of more livable cities;
- renew — through our unique intellectual and creative environment — the liberal, visual, and performing arts that in such large measure define what it is to be human.

Leadership and Management

University presidents, provosts, deans, department heads, laboratory directors, and other academic administrators rightfully understand their tasks to be to lead and serve, rather than to manage in a narrow sense. Universities are not, and must never become, simply businesses. Our essence and our human purpose run far deeper than that. Nonetheless, leadership for the 1990s



requires an understanding of rapidly shifting conditions, opportunities, and resources. The human resources of America's research universities are truly extraordinary, but our fiscal resources are dwindling in real value. I believe that the times require of us uncommon attention to financial and organizational planning and, indeed, management. This attention must come not only from administrators, but also from faculty and staff throughout the academic community. We must all act concertedly, and with wisdom and dispatch, if we are to serve our societal purposes.

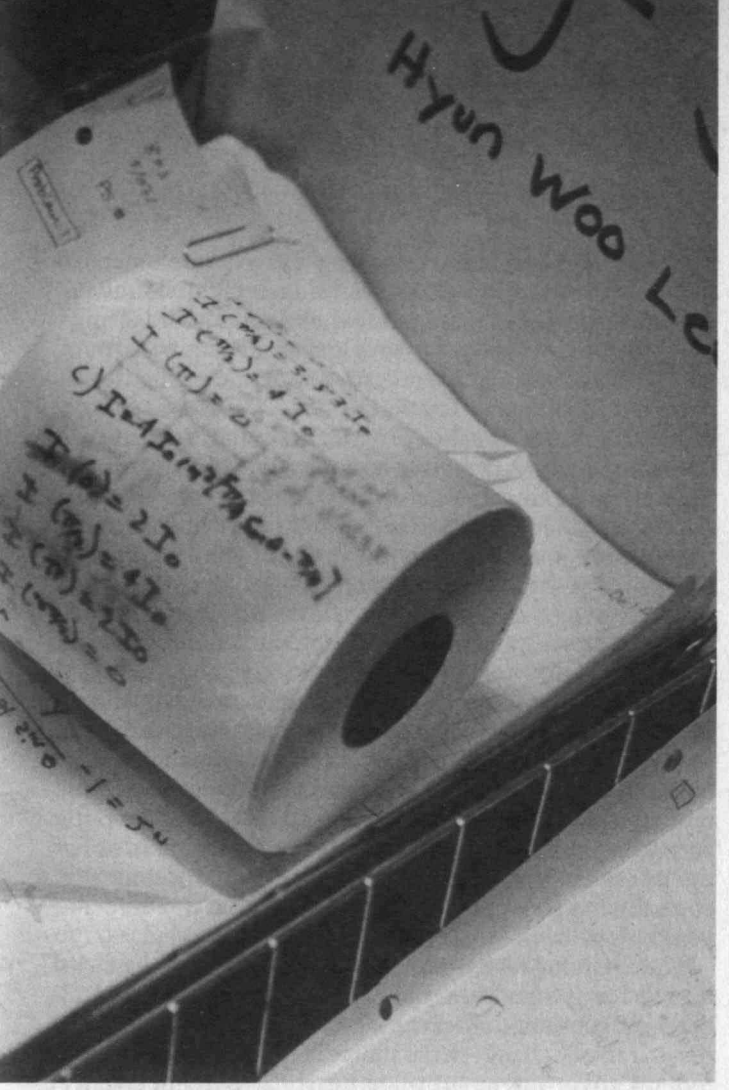
Forces

The budgets of American universities have been affected for the last several years by opposing forces. On one side we are faced with declining rates of revenue increases and a general decline in the climate for support of higher education. Dominant factors include the concern of students and their families about college costs, a leveling trend in federal resources for education and university research, and a loss of national will to address the broad spectrum of the country's educational needs.

On the other hand, we are faced with increasing costs, expectations, and obligations. The cost of what we already do is rising, and there is an escalation in what we expect of ourselves and what society expects of us.

One of the fastest growing components of most campus

PHOTO: MATTHEW BARNHART '92/TECHNIQUE



operating budgets has been student financial aid. The combination of rising tuition, rapidly declining federal scholarships and grants, and, more recently, the effects of the national recession on family incomes has rapidly accelerated the need for financial aid. Federal grants to students have declined in real value by a factor of two since 1980. As recently as 1975, 70 percent of federal student aid was in the form of scholarships and 25 percent was in the form of loans. Following the trend of so many other things in our society, by 1991, only 31 percent of federal student aid was in the form of grants, while 66 percent was in the form of loans.

At MIT, 45 percent of MIT's student aid came from the federal government in 1975, compared with 31 percent in 1991. In 1975, the federal government provided 19 percent of scholarship grants at MIT, while the Institute provided 67 percent. By 1991, the federal portion had dropped to 11 percent, while MIT provided 81 percent. The reduction in the level of federal support, and the shift from grants to loans, have significant financial consequences that have been borne by the Institute.

Research universities are subjected to strong market forces associated with hiring new faculty members of the highest quality. Salary competition is pervasive, and the costs that universities are expected to bear in order to start the research career of a new faculty member in many branches of science and engineering are measured in hundreds of thousands of dollars. In many fields, the bidding for faculty members has included the promise of greatly reduced teaching loads — a trend that we must resist.

Establishment of a healthy and vigorous research environment is often very expensive. Major costs include modern equipment and instrumentation and the associated technical support staff.

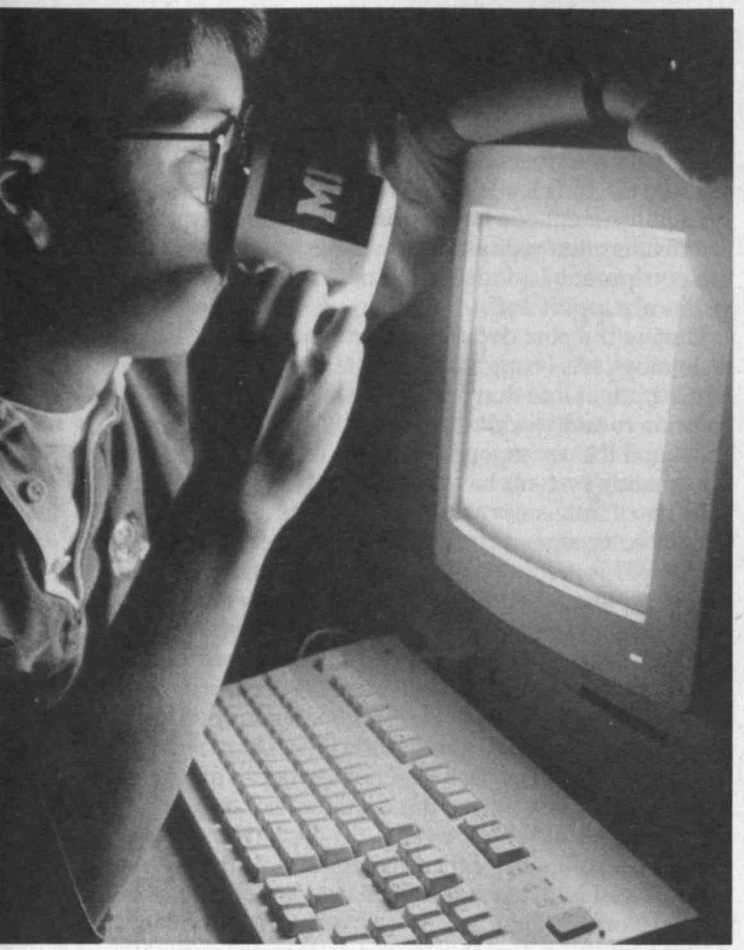
During the past decade, the revolution in information technology has brought with it an indispensable but very costly budget line that hardly existed theretofore. Microcomputers and workstations, campus network infrastructures, and the corresponding staff to manage and maintain information systems have become pervasive and essential features of university campuses. The demand for increasing capacity, speed, and sophistication has accelerated rapidly. This revolution has expanded greatly the breadth and complexity of educational and research topics with which we can deal. Yet these advances are costly. It is already common for 2 or 3 percent of a campus operating budget to be associated with information technology.

Libraries, even in their most traditional form, have been sources of particular cost escalation. The cost of acquisition, storage, and preservation of scholarly books and journals has grown rapidly during the last decade or two, and most libraries have also had to carry the capital investment in automation of many of their records and functions. As we have moved into new optical and electronic forms of information storage, libraries have tended to add to, rather than replace, traditional printed materials. Every campus library has been engaged in cutting back on the numbers of its journal subscriptions and book acquisitions. Yet during the last two decades journal subscription rates have often risen by many tens of percents in a year.

Not surprisingly, there is a rather large litany of regulatory and legal matters, as well as social mandates, that have caused costs to grow very rapidly on campuses. Issues of campus safety, access for the disabled, substance abuse monitoring, financial aid eligibility of students, conflict of interest matters, investigations of research misconduct, environmental regulation, the compliance reporting associated with affirmative action, matters of sexual harassment, and a variety of personnel issues in an increasingly litigious society are but a few of the many and substantial costs that are of relatively recent origin.

New intellectual trends, especially the growing importance of organizing to conduct highly interdisciplinary research and education, tend to bring new organizational overhead with them. The formation of new laboratories, centers, and institutes is sometimes encouraged by research sponsors, and is often believed to be necessary, in order to conduct many interdisciplinary activities. These new organizations often require new space, as well as additional staff and services.

The past two decades have brought an expanded societal role for many of our colleges and universities. We all share a responsibility to be more reflective of the rapidly changing racial and ethnic makeup of our nation, and a need to



make all career paths fully accessible to minorities and women. In addition, institutions have increasingly assumed, or had thrust upon them, various roles in the economic development of their states or regions. The daunting problems facing primary and secondary education have led many universities to undertake a variety of active roles in the improvement of K-12 systems and curricula.

Finally, there are many new services that we have either taken on, or very much wish we could better assist with, as socially responsible employers. These services reflect the changing nature and economic characteristics of the families and careers of our faculty and staff. Matters such as health care, childbearing, child care, housing, and retirement, not to mention care of the elderly, all impose new or rapidly growing costs or potential costs upon our institutions.

New tasks, new roles, and new responsibilities — but no corresponding new revenues — have become a familiar situation in academe.

A National Perspective

Academia today exemplifies the adage that misery loves company. Last year, nearly 85 percent of the nation's colleges and universities reported that securing adequate financial support was one of their three most serious challenges. During 1990-91, 45 percent of our colleges and universities announced mid-year budget cuts. This was not a one-time anomaly; 57 percent implemented mid-year cuts during 1991-92. The budgets of public universities, because they are subject to the variations and changing priorities of state legislatures and administrations, tend to fluctuate more rapidly and over a wider range than those of private institutions. But the basic financial trends of both types of institutions are depressingly similar, and the private institutions have fewer options available to them for the long-range amelioration of their financial problems.

To put higher education's revenues into some historical perspective, we must examine both how the levels and sources of revenue have changed and also how the use of those revenues has varied. The total operating budgets of all public and private doctoral-granting universities grew in constant dollars by 109 percent, from $31 billion to $65 billion, during the last 20 years. More than doubling operating budgets in 15 years hardly seems like austerity, so why are we sensing such constraint? The answer seems to be twofold: we are taking on more tasks and we are teaching more students. Enrollments have grown (99 percent in public institutions and 50 percent in private institutions) during the last twenty years, continuing to grow monotonically even during the years in which the number of 18- to 24-year-olds in the US declined by more than 20 percent.

The operating revenue of private, doctoral-granting institutions has grown from roughly $12 billion to around $23 billion in constant dollars during the last twenty years. The most dramatic change in the source of these funds is that the federal government supplied nearly 30 percent twenty years ago, but only about 18 percent today. The fraction of operating revenue (26 percent) derived from tuition and fees has increased slightly during this period, while that arising from endowment has remained constant at about 9 percent. During this period, the fraction of operating revenues derived from auxiliary activities, including hospitals and federally funded research and development centers, has increased substantially, from 29 percent to 40 percent. The trends for public universities are similar, but, of course, they have a high dependence on state support (approximately 40 percent across all such schools, but with wide variations among them).

Tuition across the country, especially that of private universities, has rather consistently followed the ups and downs of variations in the consumer price index (CPI), but for fifteen years the annual increases have been greater than the CPI. This is because the cost of the majority of goods and services needed by universities — such as scholarships and fellowships, books and journals, faculty and staff salaries — tends to rise more quickly than the CPI. Hence, while general inflation has been a primary driver of tuition, the specific costs borne by tuition have grown even more rapidly. It should be noted that while the tuition of the major private universities grew by nearly 300 percent from 1976 to 1991, its real growth, i.e., growth adjusted for inflation, was 55 percent. Interestingly, the contribution of tuition to the operating budgets of these universities grew by only about 3 percent during the past fifteen years.

PHOTO: STEPHEN HAU '92/TECHNIQUE

MIT's Budget

How is MIT's budget faring in the current climate? The simple answer is that we are in a stronger position than many of our sister institutions, but that the forces on our budget have reached a critical point, one that requires concerted, Institute-wide action if we are to remain excellent and rebuild some flexibility to do the things that we believe to be important.

Our situation differs somewhat from that of most research universities. Because of our focus on science and engineering, and the consequent dependence on federal funding, we are particularly sensitive to government policy and budgetary changes. On the positive side, our historically strong relations with the private sector are important and growing assets.

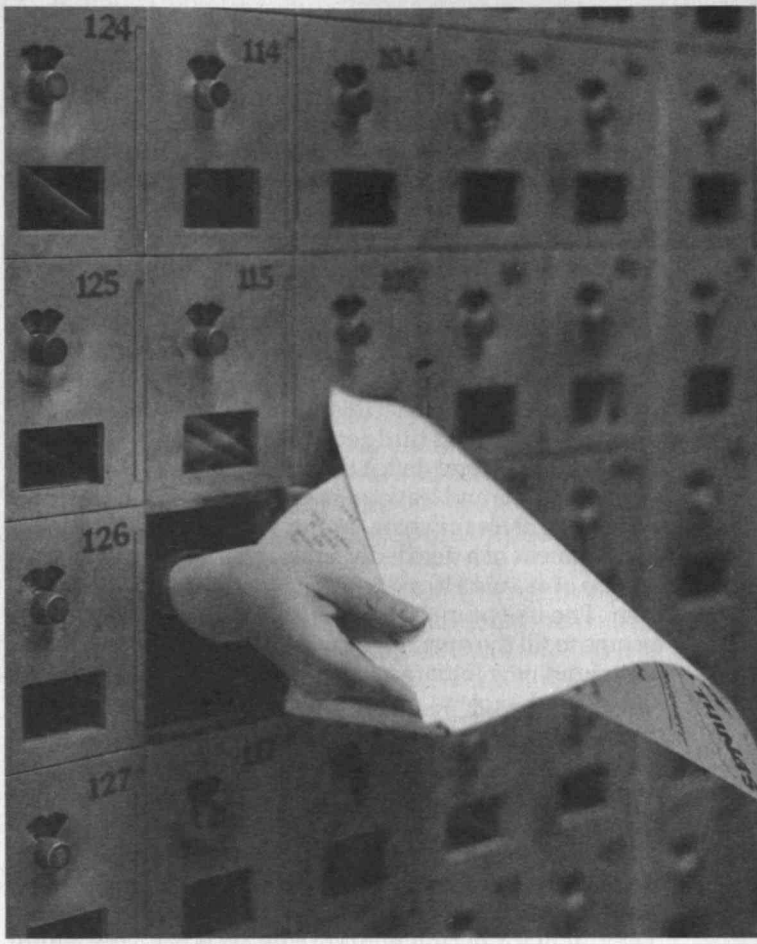
To examine our current situation, note that we have only three primary sources of revenue — tuition, federal and industrial research funds, and private support, including gifts and investment income.

Tuition rates are set annually at the Institute's discretion, but obviously must reflect the realities of the nation's economy, the corresponding need to supply financial aid, and our desire to remain accessible to bright students regardless of their family's financial situation. While tuition will continue to grow somewhat, MIT has begun to slow its rate of growth; this year's increase was 6.5 percent, the second lowest increase in 20 years.

Federal research support is earned by the efforts, innovation, and high intellectual quality of MIT's faculty, but it also depends on the congruence of our goals with those of the federal government and is subject to the shifting nature of the federal/university partnership. Research support at MIT has nearly leveled out during the last two years.

Private support is received in the form of gifts, grants, and bequests from alumni, alumnae, and friends of the Institute and from foundations and corporations. The development of private support requires considerable concerted effort and stewardship, and ultimately is a function of our institutional quality. Donations to MIT have increased very substantially during the five years of the *Campaign for the future*, and our endowment has grown from $1.2 billion to $1.6 billion in market value over that period, while total invested funds have increased in market value from $1.4 billion to $1.95 billion.

The state of the budget is crystallized when we set tuition levels and, of course, when we balance costs and revenues. Flattening research income, despite the increase in private support, has left us in a position in which there is nearly a direct relationship between annual tuition increases and the magnitude of faculty and staff salary increases. This is not a healthy circumstance. I believe that we must constrain the rate at which tuition grows, but also that we must retain our ability to pay the salaries and wages required to retain and appropriately reward faculty and staff of the highest quality. This dilemma must be resolved.



MIT's endowment grows through the receipt of gifts and the investment of its funds. During the period of the *Campaign for the future*, we have done well by both measures. For example, we have been able to create 58 new full professorial chairs and 33 career development professorships. Each year we spend a portion of the interest earned by the endowment equaling between 4.5 and 5.0 percent of its principal. Of course, on the average, the endowment earns more than this, but by policy we plow the difference back into the principal of the endowment, so that it will grow at least at the rate of inflation. In this way, we maintain the purchasing power of the endowment over time so that, for example, professorial chairs and student fellowships retain their value in perpetuity.

There are two key measures to consider when we attempt to balance our operating budget — the *deficit* and the *operating gap*. The operating gap is the difference between our expenditures and directed revenues such as tuition, research funds, fees for service and most endowment income. This gap must be filled by discretionary resources in the form of annual unrestricted gifts, grants, and bequests. If the addition of these discretionary resources still does not bring our available resources to the level of our expenditures, we are left with a deficit. For the past 15 years, the operating gap has averaged around $5.7 million, but for the last three years this gap has ranged between $9 million and $13 million. The deficits between

PHOTO: BENSON WEN '92/TECHNIQUE

1976 and 1988 were very modest, averaging nearly zero, with small surpluses in a few years. In 1989 and 1990, deficits grew to around $4.5 million. In 1991 we were able to bring it down to $300,000, but only because there was an unexpectedly large amount of unrestricted gifts and bequests received that year to fill the operating gap. In 1992 our deficit grew to $6.3 million.

The result of recent budgetary pressures, therefore, has been that our annual deficit has been running at about $5 million and is projected to increase further. This is troubling. Despite the fact that this is less than one percent of the campus operating budget, it is clear to all who have observed the federal deficit that, if unchecked, its effect will grow over time and leave an unfair penalty for the Institute in the downstream years. In my view, however, it is the development of a decidedly substantial, structural operating gap of at least $10 million that is of the most serious concern. The use of much of our annual, unrestricted gift income to fill the operating gap represents a loss of flexibility to fund new initiatives, to seed innovative educational and research projects, and to ameliorate our growing financial aid burdens. It also does not bode well for the appropriate compensation of faculty and staff if this situation is left unchecked.

Growth

A recent examination of the growth of faculty, students, and staff at MIT over the last 15 years indicated that in many ways our trends are similar to those of other major research universities around the country, although in one important measure, faculty size, we are somewhat distinct. We have maintained an essentially constant faculty headcount during this period while many other institutions expanded. Currently, we have 966 assistant, associate, and full professors, 73 percent of whom are tenured. The discipline of maintaining this constant faculty size, I believe, has lessened the depth of financial pressures at MIT relative to that at some universities, but it has not eliminated them.

MIT's undergraduate enrollment has stayed essentially stable at 4,300, while our graduate enrollment has grown by almost 1,000 — to 5,200 — during this period.

As at virtually every other research institution, there has been an increase in staff during this fifteen year period, especially during the first few years. Administrative, support, and service staff have increased roughly 7 percent, from 3,699 in 1976 to 3,976 in 1991. Why? This growth was the result of such factors as an increase in services required by faculty for their research and educational activities, a 70 percent growth in the headcount of other academic staff,* the increasing bureaucratic overhead required to conduct sponsored research programs and to comply with the upward spiral of federal regulation, the establishment of a pervasive computing environment, the establishment of a major organization for fund raising, and the development of a comprehensive medical department. Simply put, we have grown in complexity in response to enhanced internal needs and expectations and to externally imposed requirements. Unfortunately, many of these new tasks have not brought with them new revenues.

It is fair to say that by far the bulk of growth of administrative, support, and service staff has been driven by academic needs. Indeed, the size of the staff on the administrative side of the house (i.e., those reporting to the vice presidents) is at virtually the same level (2,200) as in 1976, having grown slightly and then been reduced in the early 1980s. The administrative, support, and service staff in the academic sectors (schools, departments, and laboratories), however, has grown by 16 percent — from 1,481 to 1,721 — during this period, reflecting the increasing need and demand for academic support services. Similarly, research staff increased in headcount by 47 percent — from 650 to 953. Each of these additions has been a conscious, local decision, ultimately agreed to through the deans or directors and the provost.

Revenue Enhancement

There are only two ways to bring a budget into balance — increase revenues or cut costs. In my view, both are called for at the present time. In examining both

** Other academic staff includes instructors, lecturers, adjunct faculty, visiting faculty, postdoctoral fellows and associates, senior research scientists, visiting scientists, coaches, and medical staff.*

PHOTO: MATTHEW BARNHART '92/TECHNIQUE

options we must always remember the obvious — our mission is not a financial one; it is one of teaching, research, and service. Our revenues are only the means to an end, and the structure of our budget should be a direct reflection of our substantive goals and aspirations.

I am confident that the excellence of our faculty and students and the quality and innovative nature of faculty activities will assure that our federal research support will remain strong. But there are two caveats. First, by small step upon small step, federal agencies are backing away from paying the full costs of the programs that they sponsor, including research and fellowships. Second, the directions of federal research policy are in flux as a natural consequence of the end of the Cold War era and because of the advent of new concerns associated with issues such as the environment, health care, and industrial competitiveness. America's research universities must respond to these changing conditions, but more importantly, have a responsibility to help shape policies and programs in the national interest.

There are many object lessons and reasons for optimism in recent MIT initiatives. Let me cite two — the Leaders for Manufacturing Program and the MIT Japan Program. Leaders for Manufacturing is an innovative master's level program, designed and implemented in close working partnership with several US manufacturing firms, to educate a new breed of managers and engineers equipped with a broad, integrated understanding of manufacturing and management science, technology, and organization in a contemporary, international context. The MIT Japan Program provides a number of MIT undergraduates with in-depth Japanese language training, combined with education in Japanese culture, history, and business practice, and places them, upon graduation, as interns in Japanese industrial and research organizations. These students then return to the US with a detailed working knowledge and understanding of Japanese practices and techniques, as well as with the general benefits of international acquaintances and cultural experiences. Both of these programs respond to a clear national need; both are conducted in a world-class manner; and both have created very substantial new revenue streams for operations and student support, because the importance and effectiveness of the investment have been made clear to corporations and to the government. It also should be noted that both are primarily educational activities.

We should move forward with confidence that programs conceived with excellence, educational innovation, and long-term economic and social relevance will still find appropriate partners and sponsors. These partners and sponsors should come increasingly from the private sector, but it would be unrealistic to imagine that this will to a major extent replace federal funding. It remains a necessary function of the federal government to support the advanced education and research on which the future so directly depends.

We and our colleagues must continue to press for federal support of the full costs of programs, and to press for merit as the prime determinant of grants, contracts, and facility funding. Academic earmarking has reached the extraordi-nary level of nearly a billion dollars in the new federal budget — more than was contained in the total of budgets during the previous decade. Although we must recognize legitimate concerns such as geographic distribution, it is not in the interest of the country to cut off the tops of its mountains in order to fill in the valleys. Surely the wisest policy for the country cannot be random selection for awards, based on the location of schools in particular congressional districts, and funded with monies removed from the already stressed resources of programs and agencies. The great public and private institutions must be maintained. They are magnets for the best thinkers and researchers, and their facilities and graduate schools are the peaks of excellence to which students from schools and colleges all over the country aspire and matriculate. The set of these institutions is dynamic, with new universities moving into its ranks the old fashioned way — by hard work and good ideas.

Having said this, the clear prognosis remains that the rate of growth of federal funds is being attenuated and the number of universities capable of productively conducting high-quality research and education is expanding. Substantial growth in overall research funding is therefore unlikely in the near term.

The outlook for private support is something of a mixed message. Through the very successful *Campaign for the*

future, we have significantly increased MIT's level of private support. Our alumni, alumnae, as well as our staff and faculty, have worked very hard and effectively to make this happen. We must meet the challenge of continuing the momentum generated by the campaign. Resource development will need to become more deeply ingrained in the MIT culture. Continuing to increase the level of private support will be a strong challenge, but one that I have confidence we can meet.

The other side of private support, of course, is that the real value of our endowment depends on the performance of the market and the quality of our investment strategies. Our track record is good, but it also appears to most observers that returns will not be as great in the coming years as those that were possible during the last decade. Thus, major expansion of private support is somewhat problematic.

Learning Institutions

We cannot assume that the resources of universities in general, and of MIT in particular, will grow significantly in the years immediately ahead. Thus, the only way to assure that we maintain excellence and have the flexibility to strike out in exciting new intellectual directions, to be a high quality employer of faculty and staff, and, above all to meet our responsibilities to our students and the nation, is to do less, do different things, or gain efficiency. In my opinion, we must do all three. Indeed, there is no choice. We must be as open to new ways of thinking about how we operate and how we teach as we are to new lines of research and scholarly inquiry.

Universities must thoughtfully and continuously review and prune their programs and organizations in addition to creating new ones as times and intellectual frontiers change. Similarly, we must continuously review and renew the services that we provide to our faculty and students. Only in this way can we assure the excellence of what we are and what we do.

I am fond of quoting Frederick Terman, an MIT alumnus who became engineering dean and provost at Stanford. When once asked whether he wanted his university to be a teaching institution or a research institution, he replied that it should be a learning institution. Today, universities must also be learning organizations in the sense developed by Peter Senge of the Sloan School of Management: organizations that come to understand and react wisely to the opportunities and constraints they face. We must study the work of our own management scholars, and we must learn from the substantial transformations of industries and other organizations around the world during the last decade.

The MIT Ad Hoc Faculty-Administration Committee on Indirect Costs and Graduate Student Tuition, for example, has proposed an MIT Quality Initiative to adopt the principles and lessons of Total Quality Management (TQM) within the Institute. I would use the term 'adapt' rather than 'adopt,' because we are a university, not a manufacturing or commercial service organization. However, the results of quality initiatives in a variety of settings have been so substantial that we cannot afford not to commit ourselves to serious exploration, experimentation, and implementation of these concepts and techniques.

In fact, there are three major areas in which such activities are already underway. First, the entire Information Systems group has for several months been studying and planning full-scale implementation of a TQM program to improve their service to the Institute community and to gain efficiencies in their operations. Second, campus departments that provide human services — ranging from Admissions to the MIT Press, and from Personnel and Public Relations to the Medical Department — have been working with external and internal experts to develop an approach to quality management that is appropriate for the MIT culture and that merges with their Building on Differences program (a program designed to enhance productivity and the quality of professional life in an organization of highly diverse individuals.) Third, a faculty initiative resulted in a major grant from the IBM Corporation that made possible a week-long seminar in their facilities that was attended by 50 faculty members and 25 staff and administrators from MIT in early September. The opportunity for this cross section of the Institute community to study and plan together how to enhance the excellence of all that we do as an institution was extraordinary. We shall build upon the momentum developed by this group.

It is my belief that we must increasingly consider and operate MIT as an integrated organization. Our faculty, students, and staff must act more as a seamless community. Despite the fact that we must always be an environment in which individual achievement and disciplinary excellence are fostered, we must pay increasing attention to integrated activity and teamwork. In research and education, new approaches to teamwork and interdisciplinary problem solving are flowing naturally from the complexity of many of the most interesting areas of modern research and scholarship. Similarly, institutional complexity and constraint require that we approach our administrative support activities with greater communality of purpose and explicit cross linkage.

We must in these and many other ways seek to improve the quality and efficiency of our support services. But these efforts must also touch the heart of what we do — teaching and research. Are we teaching the right courses in the right way? Do we maintain archaic approaches to classrooms and laboratories? Are we making the appropriate use of the very information technologies that we develop here? Is the information flow among faculty, students, and administra-tors designed to enlighten or to generate entropy? Can we gain greater efficiency in the more mundane of our duties in order to free time and resources for the really important aspects of academia? Do we have too many committees? Do we have the proper balance of formal and informal contact with our students? Are research proposals prepared in such a way that faculty can concentrate on their essence and qual-

ity rather than the bureaucratic details? Do we communicate effectively with the public, the government, the business world, and our alumni and alumnae? Are there redundancies in our operations? Do we consciously determine where we should cut back in order to make new programs possible? Do we maintain the proper balance of teamwork and individual activity? Do we allow responsibility to be exercised and decisions made at the levels where knowledge and understanding are greatest? Do we strike the congruence between the goals and needs of the Institute as a whole with those of individuals within it? Do we invest our intellectual and financial resources in the future or squander them on issues of the moment? Do we learn and improve as an organization as well as individually?

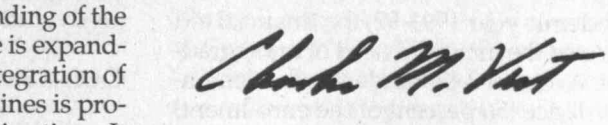
Ensuring The Future

Our times are times of change and uncertainty ... and promise. In four decades, we have moved from an era in which the United States produced over half of the world's gross product to one in which we produce just over 20 percent. It is a world in which challenges of energy, environment, and human survivability are becoming paramount. It is a world in which idealism and concern for our fellow men and women have become rare commodities.

And yet, it is a world in which our understanding of the basic nature of life and of the physical universe is expanding exponentially. It is a world in which the integration of knowledge across seemingly disparate disciplines is producing startling new insights and intellectual directions. It is a world in which the range of temporal and physical scales with which engineers and scientists can operate has become vast beyond belief. It is a world in which the blending and cross-currents of among men and women of different races and cultures can give rise to new synergies for the advancement of civilization.

It is a world in which we at MIT can and must dream of new futures. And as we do, we must cherish those values that have made us great. We must demand excellence. We must celebrate both the solitary, iconoclastic scholar and the multi-disciplinary group. We must value both abstract thought and practical application. We must treasure both the diversity of our community and the communality of our deeply rooted values. We must, in sum, hold to a vision of MIT that draws on the best we have and the best we are, and that gives to the world the full measure of our talent and imagination.

These are the things that are at stake as the economic and societal under-pinnings of the American research university, and of MIT in particular, shift and change. These changes must be met with a clear-headed view of financial realities. We must be both prudent and farsighted, and we must act carefully but decisively to shape our finances, our activities, and our organization in order to retain and enhance the excellence that is so critical to a vibrant future for ourselves and for our fellow men and women.

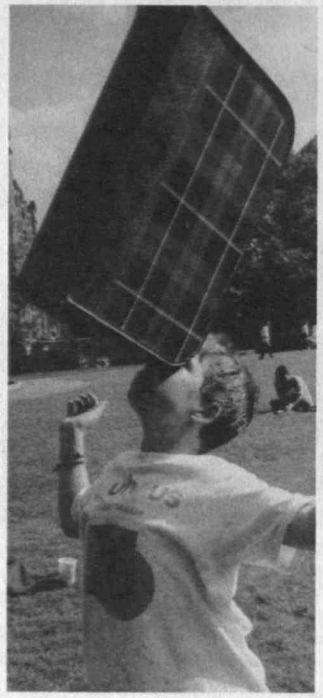


Charles M. Vest
October 1992

PHOTO: BENSON WEN '92/TECHNIQUE

STATISTICS FOR THE YEAR

REGISTRATION



In 1991-92 student enrollment was 9,541, compared with 9,628 in 1990-91. There were 4,325 undergraduates (4,389 the previous year) and 5,216 graduate students (5,239 the previous year). The international student population was 2,117, representing 9 percent of the undergraduate and 33 percent of the graduate populations. These students were citizens of 103 countries. (Students with permanent residence status are included with US citizens.)

In 1991-92, there were 2,589 women students (1,433 undergraduate and 1,156 graduate) at the Institute, compared with 2,593 (1,451 undergraduate and 1,142 graduate) in 1990-91. In September 1991, 368 first-year women entered MIT, representing 35 percent of the freshman class of 1,053 students.

In 1991-92, there were, as self-reported by students, 2,052 minority students (1,643 undergraduate and 409 graduate) at the Institute, compared with 1,978 (1,582 undergraduate and 396 graduate) in 1990-91. Minority students included 347 African Americans (non-Hispanic), 34 Native Americans, 423 Hispanic Americans, and 1,248 Asian Americans. The first-year class entering in September 1991 included 457 minority students, representing 43 percent of the class.

DEGREES AWARDED

Degrees awarded by the Institute in 1991-92 included 1,039 bachelor's degrees, 1,137 master's degrees, 31 engineer's degrees, and 514 doctoral degrees — a total of 2,721 (compared with 2,771 in 1990-91).

STUDENT FINANCIAL AID

During the academic year 1991-92, the financial aid program reflected the increased need of undergraduate students. A total of 2,473 students who demonstrated need for assistance (56 percent of the enrollment) received $28,327,000 in grant aid and $10,278,000 in student loans from all sources. The total, $38,605,000, represents a 10 percent increase in aid compared to last year.

Grant assistance to undergraduates was provided by $8,475,000 in income from the scholarship endowment; $859,000 in outside gifts; federal grants (including ROTC scholarships) totaling $3,151,000; and $2,072,000 in direct grants from non-federal outside sources to needy students. In addition, $13,769,000 in scholarships from MIT's unrestricted funds was provided to undergraduates. The last figure includes the special program of scholarship aid to needy minority group students, which represented $275,000, and the MIT Opportunity Awards, which accounted for $928,000. An additional 452 students received grants irrespective of need from outside agencies totaling $2,088,000. The undergraduate scholarship endowment was increased by the addition of $6,582,000 in new funds (more than last year's increase), raising the principal of the endowment by 10 percent to $75,090,000.

Loans totaling $9,619,000 were made to undergraduates, a 6 percent increase from last year. Of this amount $1,291,000 came from the Technology Loan Fund, $2,856,000 from the Perkins Loan Program, and $5,472,000 from the state-administrated Stafford Guaranteed Loan Programs and other outside sources.

Graduate students obtained $2,570,000 from the Technology Loan Fund. In addition, MIT loaned $841,000 to graduate students under the Stafford Guaranteed Student Loan Program. The total, $3,411,000, represents a 9 percent increase over last year's level. Graduate students obtained $3,853,000 from outside sources under the Stafford Guaranteed Student Loan Program, 10 percent more than last year, and $121,000 from federal Supplemental Student Loans. Graduate students also received $1,536,000 in Perkins Loan funds.

The total amount of loans made to undergraduate and graduate students was $18,540,000, a 9.2 percent increase over last year.

For the first time in many years, the number of needy undergraduate students receiving aid decreased slightly. The average need, however, increased — reflecting, in part, the higher proportion of students from low income families. This year the percentage of freshmen coming from the lowest national income quartile was 23 percent, the largest proportion ever. In addition, the financial aid program funded the higher need of families as the recession deepened and unemployment increased.

The total need for financial aid for undergraduates was $41,639,000. The average need for aid rose by 8.3 percent to $16,765. In the aggregate, the financial aid program required $19,427,000 from needy students' family resources, and provided $41,639,000 in aid dollars. As in years past, the aid program accounted for two-thirds of needy students' total costs.

CAREER SERVICES AND PREPROFESSIONAL ADVISING

For the second year in a row, the economic climate was not promising for graduating students entering the job market, or for students looking for summer jobs. The number of

PHOTO: BENSON WEN '92/TECHNIQUE

employers recruiting through the Careers Office totaled 371, a fraction less than last year's figure, which was down 20 percent from 1989-90. Nevertheless, as in previous recessions, MIT job seekers generally fared remarkably well. This was especially true of students in engineering and management. They continued to find good summer jobs and good jobs at graduation. Students in other disciplines felt the bite more sharply. The last two years have been difficult for graduates in architecture and urban studies, and the market has been extremely tight for PhDs in mathematics and physics hoping for jobs in academia.

Salary offers in most fields moved up at less than the inflation rate. Students enjoying the largest gains were SBs in chemical engineering, who received offers 7 percent higher than the year before; SMs in mechanical engineering, who received offers nearly 8 percent higher; and PhDs in electrical engineering, who found industry willing to make offers 15 percent higher.

There was a jump in the number of MIT applicants to medical school, paralleling an increase in the nation at large. Preliminary data show 131 MIT candidates, up from 119 at the same time last year. This year's candidates included 91 undergraduates, 2 graduate students, and 38 alumni/ae. Of the undergraduates, 44, or very nearly half, were women; the graduate student and alumni/ae candidates were divided exactly (20/20) between men and women. There was the same equal balance between men and women in 1991, when 83 percent of the women were accepted and 77 percent of the men. The increasing number of candidates in the nation at large has increased the odds a bit, but MIT's candidates are again likely to have done well.

Finances

As reported by the Vice President for Financial Operations and by the Treasurer, the total financial operations of the Institute, including sponsored research, amounted to $1.08 billion — a decrease of 0.2 percent from 1990-91. Education and general expenses — excluding the direct expenses of departmental and interdepartmental research and the Lincoln Laboratory — amounted to $509.7 million during 1991-92, compared with $488.5 million in 1990-91. The direct expenses of departmental and interdepartmental sponsored research on campus increased from $229.4 million to $231.5 million, and direct expenses of the Lincoln Laboratory's sponsored research decreased from $367.7 million to $342.1 million. Current revenues used to meet the Institute's operating expenses totaled $1.07 billion, augmented by $6.8 million in current gifts and $6.3 million of other fund balances.

At the end of the 1992 fiscal year, the Institute's investments, excluding retirement funds, student notes receivable, and amounts due from educational plant, had a book value of $1.5 billion and a market value of $1.95 billion, compared to last year's book value of $1.4 billion and market value of $1.77 billion.

Physical Plant and Campus Environment

Conservation of resources continues to be a major focus at the Institute. During the year, MIT joined the Environmental Protection Agency's Green Lights Program, which is aimed at reducing air pollution caused by emissions from electric-generating plants by reducing the overall demand for electricity. By joining this program, the Institute has committed to installing energy efficient lighting in 90 percent of its buildings, where it is cost effective, over the next five-year period.

In other conservation efforts, several water-saving initiatives were implemented this year, including the elimination of once-through cooling systems and the limited use of water from the Charles River for irrigation purposes. As a result of these and future efforts, the Institute should realize a 25 percent reduction in water usage.

Progress continues on the construction of the Biology Building. The foundation was completed in late spring and work on the superstructure was underway at year's end. A 6,000 square-foot addition to Haystack Observatory was completed during the year, as was the total renovation of a property at 477-479 Commonwealth Avenue in Boston, which now houses 60 members of the Alpha Phi Sorority. Other major design and construction activities that took place during the year included a continuation of work at the former Cabot Building (Building E56) in the areas that will house the Dibner Institute and Burndy Library, and the permitting and design efforts on the proposed combined-cycle cogeneration project. The actual environmental permit for the cogeneration plant was received early in the spring. Major maintenance activities completed during the year included reconstruction of the concrete plaza surrounding the Compton Building (Building 26) and replacement of the roofing system on Building 1.

Issues associated with ever-increasing regulatory requirements regarding the environment, health, and safety continue to necessitate close monitoring to ensure that the Institute remains in compliance. As a result of recent passage of the Americans with Disabilities Act (ADA), which requires that any employer with 15 or more employees provide reasonable access for handicapped individuals, the Institute has established a committee to identify locations where access is difficult and make recommendations for overcoming the problems.

Resources used in preparing this report included the Caspar Database of the National Science Foundation; *Science and Engineering Indicators*, 1991 Edition, National Science Board; *Science and Technology in the Academic Enterprise: Status, Trends and Issues*. October 1989; *Higher Education in a Changing Economy*, edited by K. H. Hanson and J. W. Meyerson, American Council on Education, 1990; *Inflation Measures for Schools and Colleges, 1991 Update*, Research Associates of Washington; *Higher Education Revenues and Expenditures, Institutional Data FY1990*, Research Associates of Washington; *Trends in Student Aid 1982-1992*, College Board; *Campus Trends 1992*, edited by Elaine El-Khawas, Higher Education Panel Report Number 82, July 1992, American Council on Education.

MIT LIFE INCOME FUNDS

MR. AND MRS. ARIEL A. THOMAS

HOME: St. Petersburg, Florida
Coventry, Rhode Island

CAREER: With an S.B. in civil engineering from MIT (1936) and an S.M in sanitary engineering from the University of Illinois (1938), Ariel Thomas first worked as an engineer for the state of Illinois. After serving as a major in the U.S. Army Sanitary Corps during the war, he returned to MIT in 1946 as an assistant professor in the Department of Civil Engineering and in 1950 joined the Water Pollution Control Division of the U.S. Public Health Service. In 1954, he began a 29-year career with the civil and sanitary engineering firm Metcalf & Eddy, supervising and consulting for sewer, pollution control and other public works projects all over the eastern United States. He was a senior vice president at Metcalf & Eddy when he retired in 1983.

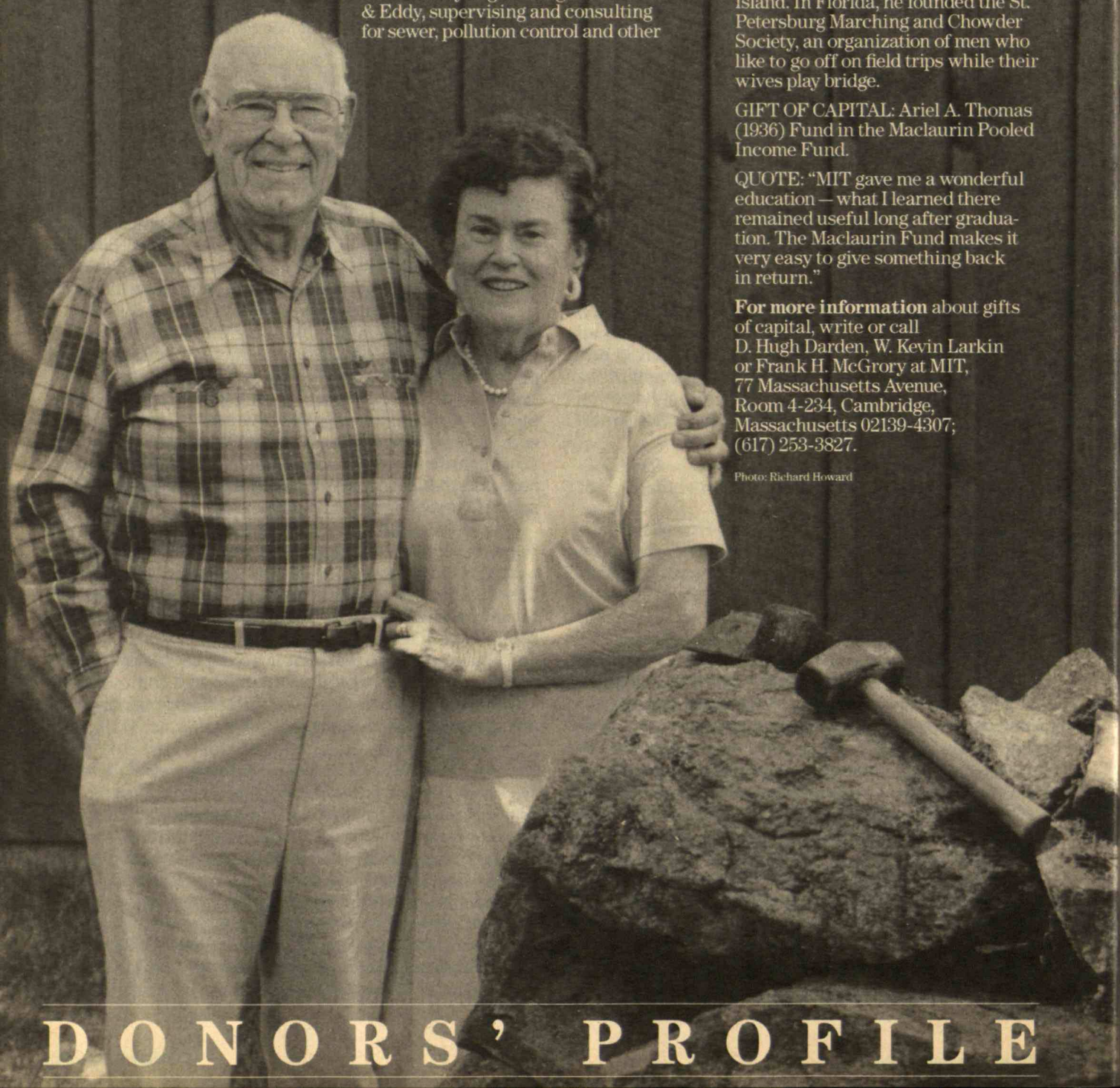
Ariel met his wife Avis at a party in his home town of Woonsocket, Rhode Island, in 1933 while she was in high school. They married in 1939 and have one married daughter and two granddaughters. Now they divide their time between their two homes. In Rhode Island, Ariel takes part in a state fresh-water evaluation project run by the University of Rhode Island. In Florida, he founded the St. Petersburg Marching and Chowder Society, an organization of men who like to go off on field trips while their wives play bridge.

GIFT OF CAPITAL: Ariel A. Thomas (1936) Fund in the Maclaurin Pooled Income Fund.

QUOTE: "MIT gave me a wonderful education — what I learned there remained useful long after graduation. The Maclaurin Fund makes it very easy to give something back in return."

For more information about gifts of capital, write or call D. Hugh Darden, W. Kevin Larkin or Frank H. McGrory at MIT, 77 Massachusetts Avenue, Room 4-234, Cambridge, Massachusetts 02139-4307; (617) 253-3827.

Photo: Richard Howard



DONORS' PROFILE

Do You Know These Seven Ways to Increase Your Returns on Technology Transfer?

Technology Access will help you with six of them. You will have to supply the seventh.

Technology Access Report is the only concise, practical, independent newsletter devoted to helping you master the technology transfer process.

And since no publication can anticipate all your unique concerns, your subscription includes the toll-free ***Technology Access Hotline***. You'll enjoy prompt, confidential answers to your tech transfer questions.

Here's how ***Technology Access*** helps you master six critical success factors for technology transfer and commercialization:

1 Know the technology. *Technology Access* saves you hundreds of hours of research by reviewing a wide range of technology in non-technical, eminently readable English–ranging beyond your primary resources.

Said **Procter & Gamble's** Brandon Wiers: *"The **Report** has helped me get up to speed very quickly, as P&G expands into new areas. The **Hotline** has already saved me hours of chasing down contacts."*

2 Know your own strategic goals and technical capabilities. Consultant Jeff Staley of **Generics Group USA** showed *Technology Access* readers how to perform technology audits and develop "technology asset plans," so you can decide what to develop internally or source from outside.

Key new trend: Universities are "packaging" related technologies from more than one institution. And **Sandia's** Dan Arvizu says the nation's 700 federal labs are assessing their own core capabilities, as they respond to industry's needs.

3 Know your potential partners–and competitors. *Technology Access* profiles the tech transfer operations of companies and not-for-profits in all sectors, so you can benchmark your performance against the world's best–and be prepared to deal when an opportunity arises.

Note: Every article ends with an easy-to-spot "Access Block" complete with name, address, phone and fax numbers. You save time by calling direct to the source.

4 Expand your network of technology suppliers, users and partners. *Technology Access* will expose you to the full spectrum of innovators: universities large and small, federal and independent labs, medical centers–and companies.

Said one scout for a major pharmaceutical firm: *"I didn't realize until I started reading **Technology Access Report** how much medical research goes on in the federal labs outside the National Institutes of Health. Thanks for opening my eyes!"*

Tip: Use our Calendar and conference recommendations to decide which to attend–and which meetings to read about in our Conference Reports. *Tech transfer is a contact sport.* We'll make sure you make the right ones.

5 Master the process. *Technology Access* shows you how to manage this powerful business strategy. Sure, too many bureaucracies, public and private, are consumed with process. But–as TQM, lean production and concurrent engineering have taught us, you ignore process at your peril. **Drexel** and **Oregon State**, and the **National Institute of Standards and Technology** as well as **GM**, are applying the precepts of TQM to their operations. So can you.

6 Scan the horizons. *Technology Access* will keep you from being blindsided–and alert you to unexpected opportunities. Information overload notwithstanding, it's critical to resist narrowing your focus. Biochemist Kathy Ku, **Stanford's** new licensing director, said, *"I depend on **Technology Access** for news and tactics I don't find in my usual sources."*

Only you can supply the seventh success factor.

7 Add *passion* to your tech transfer. John Preston's **MIT** licensing office has negotiated equity shares in startups with over $1 billion in combined market cap.

Here's John's formula: mix quality technology, management, inventors and investors. Then structure the deal with balanced incentives, so all will strive passionately for your venture's success.

Our passion is your success.
You benefit from our beliefs on every page: your business of technology transfer is *challenging*, but *manageable. It is important, stimulating* and *fun.* And ***Technology Access Report and Hotline*** will help you make it *very profitable.*

Order now to receive:
FREE *Technology Transfer Key Resource List*–durable, concise, annotated reference you'll rely on every day...
FREE heavy-duty padded binder to keep your issues and ***Resource List*** handy...
FREE use of the ***Technology Access Hotline***–quick answers to all your tech transfer questions, *and...*
PASSION–ENHANCING DISCOUNT
Save **$50** when you call today.

OUR GUARANTEE: *You will get your money's worth from Technology Access Report and Hotline–or your money back.*

☐ ***Yes!*** Start my 12 monthly issues of ***Technology Access Report*** right away. I will receive the binder, ***Resource List*** and ***Hotline*** upon payment. Fee: Only **$397–SAVE $50** from regular price. CA residents, add 7.25% sales tax. Outside North America, add $75.

☐ Please invoice me. ☐ Payment enclosed. (Save another $25.) ☐ Charge my Amex/Visa/MC #

Exp. Signature

Name Title

Organization

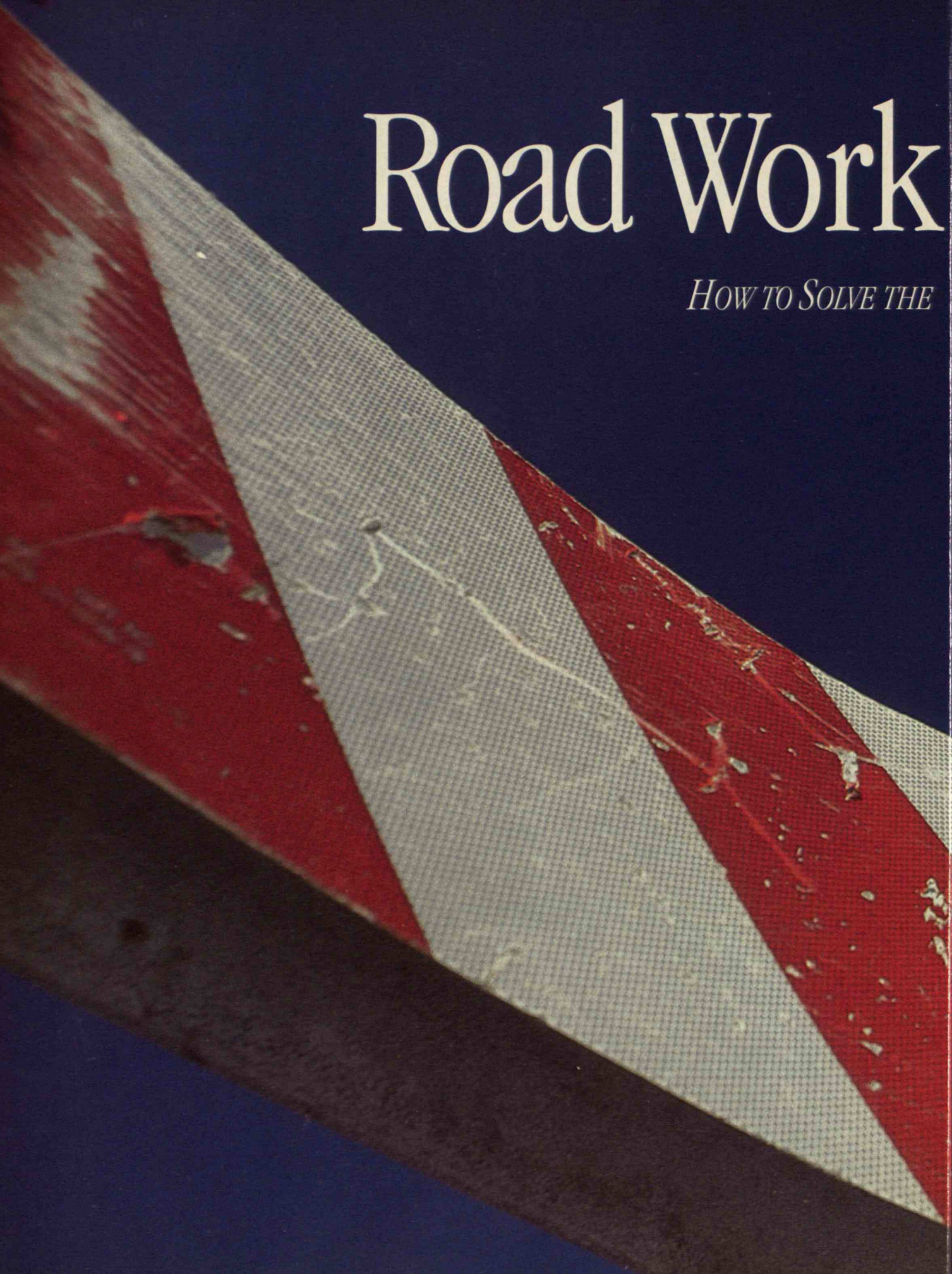
Address/Mailstop

City State Zip

For fastest service, call toll-free **1-800/959-1059**, fax **510/549-4342**. Headquarters: 7 Mt. Lassen Dr., San Rafael, CA 94903. Bureaus: Washington, D.C., Paris, Detroit, San Francisco

Road Work

How to Solve the



Ahead

Infrastructure Crisis

It will take some digging, but efficient remedies abound for restoring America's crumbling public works.

By Clark Wieman

PHOTO: CHRIS LITTLE

TODAY about 40 percent of U.S. bridges are rated deficient. An average of 120 collapse each year, some simply because they never received a new coat of paint and were more vulnerable to the elements. Thanks partly to massive highway reconstruction that could have been avoided, the time Americans waste in traffic jams amounts to 2 billion hours annually, and could rise to 4 billion by the year 2005. And water mains and sewers across the country are reaching the end of their 80-to 100-year life spans.

We owe today's infrastructure crisis to yesterday's shortsightedness. The vision that produced our cities' subways, highways, bridges,

An emergency worker perches in a hole knocked through the basement wall of the Chicago Board of Trade, which was paralyzed by the city's underground flood in April 1992. The culprit: poor infrastructure maintenance.

and thousands of miles of water mains earlier in this century failed to provide for the care and replenishment of the infrastructure once it was built. Thus public agencies play a no-win game of triage, with tightening budgets that force them to focus on the growing number of emergencies, from water-main breaks to critical flaws in aging bridges.

Amidst the dire trends, there is good news: the infrastructure crisis is solvable. Already there have been many hopeful signs. Cincinnati, for example, recognized the full extent of its infrastructure problems in 1986 and by 1988 had a major rehabilitation program in place. Bolstered by new resources from the state gas tax and an increase of 0.1 percent on local income taxes, the city doubled its reconstruction effort. And New York City's subway system, once on the verge of shutdown, has dramatically improved since massive renovations began 10 years ago.

Although shoring up ailing physical systems is bound to cost the nation hundreds of billions of dollars, infrastructure spending can be done far more efficiently and cost-effectively than it is today. A multitude of ideas and techniques from within and outside government can move us toward a new vision of a well-run city. Roads can be smooth, bridges well kept and long-lived, and mass transit comfortable and on time. Thoughtful planning and funding choices based on a long-term view can convert cities across the country into far more pleasant places to live, while freeing up huge sums for other pressing social needs.

A Stitch in Time

The disaster last spring in Chicago—where 250 million gallons of water poured into a century-old tunnel under the city's central Loop, forcing the evacuation of 200,000 people and disrupting state, national, and even international commerce—underscores a long-running theme of many public works professionals: maintenance pays. The city's failure to invest $10,000 in repairing a small underground leak cost companies and taxpayers more than $1 billion in emergency response, property damage, and lost business.

It is safe to say that maintenance budgets in virtually all U.S. cities are inadequate: the playing field where politics and public works intersect is tilted toward new construction. Federal transportation bills, often generous toward new projects, routinely ignore maintenance. Local officials have a disincentive to spend scarce local funds on painting a bridge if the feds will buy them a new one when corrosion cripples it. Besides, maintenance doesn't generate the excitement of a ribbon cutting. There are far more political points to be won by attending a grand opening or groundbreaking than by shaking the hand of a bridge painter. As a result, few politicians carry the banner of preventive maintenance. And those who do are often forced to put off maintenance because of competition from other, more immediate concerns.

What these officials don't seem to realize is that they are flushing municipal funds down the drain. A study by a consortium of universities found that a well-run bridge program in New York City would spend roughly $150 million a year: $50 million on maintenance and $100 million on capital expenses (including major bridge rehabilitation and reconstruction). Instead, the current system commits only about $5 million to maintenance,

CLARK WIEMAN is research director of the Cooper Union Infrastructure Institute in New York City and chief author of its recent study, "Smart Money: Now Is the Time to Invest in the Physical City."

PHOTO: REUTERS/BETTMANN

pushing capital expenses to $400 million a year. That represents an annual loss of some $255 million for New York City bridges alone. And this figure doesn't include "external" costs—lost business from lower transportation efficiency, greater risks to the public, and lower quality of life.

Maintenance can provide similar paybacks in other areas of infrastructure: in New York City, where sewers are replaced at a rate equivalent to once every 250 years, seven of eight dollars now spent on sewer repair goes to costly emergency reconstruction. So it is not hard to imagine how reversing the policy of neglect can free up funds for all public agencies throughout the country. The City of Cincinnati, realizing this, recently pumped 50 percent more money into preventive maintenance.

Investing in maintenance also generates more jobs than new construction does. The record of the Port Authority of New York and New Jersey shows that dollar for dollar, maintainence employs 40 percent more workers than new building projects or major reconstruction. Because maintenance is far less capital-intensive, a larger share of total funds goes to "salaries rather than steel," in the words of New York City Environmental Commissioner Albert Appleton.

Most public agency officials understand the value of regularly painting a bridge or repairing a leaking water main before it breaks. But many political leaders need to realize that the real cost of deferring maintenance will substantially, even dramatically, exceed the cost of simply doing the work. Talk to anyone in Chicago.

Creating Revenue Streams

Keeping infrastructure healthy demands regular cycles of replacement and repair. But these are impossible when public works are funded in dribs and drabs subject to the vagaries of annual city and state budgets. Whether provided through user fees, the creation of special districts and authorities, or earmarked taxes (or a combination of these), dedicated funds are essential to well-maintained public works systems.

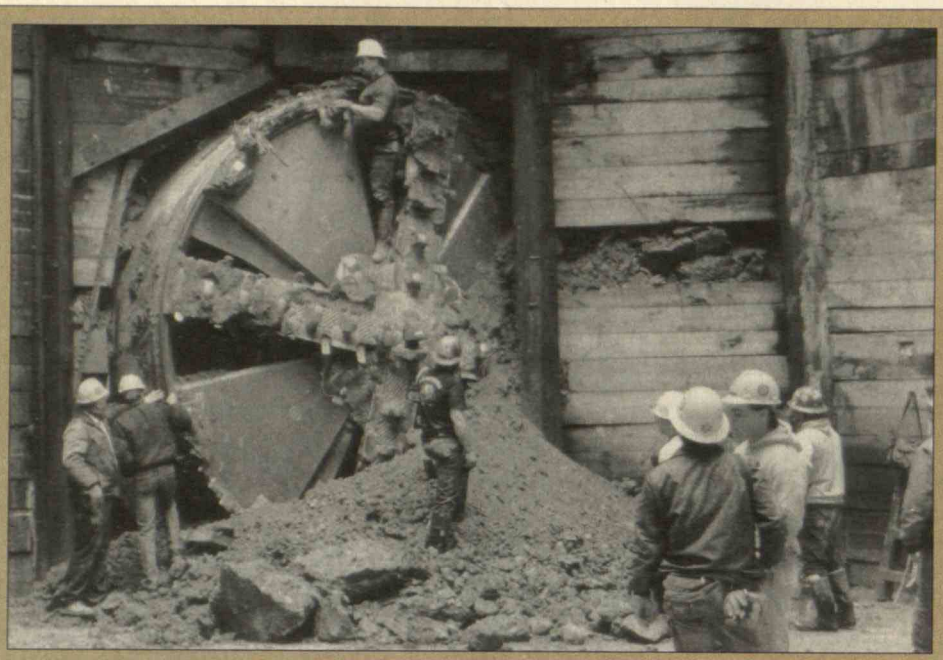
Not surprisingly, public facilities run with dedicated revenue are in far better shape than those without. New York City bridges operated by the Triborough Bridge and Tunnel Authority (TBTA) and the Port Authority—two public agencies outside city government that receive a dedicated stream of toll money—are in fine shape. Removing the tolls from the four city-run East River Bridges may have been a shrewd political move in 1911, but it marked the beginning of their physical decline. Bridges operated by the city have 0.25 maintenance workers per lane mile; TBTA bridges have 1.5 and Port Authority bridges 3.2.

Dedicated funding is also the foundation of the Boston area's effort to renovate its badly neglected water-main system. Created in 1985, the Massachusetts Water Resources Authority was given control of water-use revenues, money previously diverted to the general budget. With this secure funding stream, the authority has begun an ambitious $540 million rehabilitation and replacement program. Some 2.5 percent of the area's distribution mains are being upgraded each year, according to James Powers, the authority's waterworks manager. Steady funds have enabled the authority to plan longer-term projects as well, including a $295 million water-delivery tunnel to be started in 1994 and a $240 million tunnel scheduled for construction from 2004 to 2007.

As if the benefits of long-term funding were not clear enough, New York's Governor Cuomo has begun an

New York's Queensborough Bridge, where even the potholes have potholes, testifies to the importance of dedicated funding sources such as bridge tolls.

PHOTO: JACQUES CHENET/WOODFIN,CAMP



In a $295 million effort planned by the Massachusetts Water Resources Authority, a rock-boring machine like this one (pictured at work on the Boston Harbor cleanup project) would carve an 18-mile water-supply tunnel to supplement an aging aqueduct. Without steady funding from water-use revenues, such an ambitious undertaking might have been unthinkable.

experiment in backsliding that could remove all doubt. He recently took the New York Metropolitan Transportation Authority off the five-year budget cycles that helped rescue the city's subway system from near-collapse in the 1970s, and reinstated a one-year budget. The change compromises the agency's ability not only to design and plan long-term projects but to attract federal money. Because the federal government is loath to back projects that might not be completed, the agency could lose $306 million in matching federal funds for a vital subway tunnel link unless the state commits funding for five years. What's more, other projects planned to coincide with one another—the replacement of track ties and the addition of electrified rail on commuter lines, for example—would have to be done separately, driving up costs.

Besides losing the financial payoff, public works agencies with short-term budgets miss out on an important side benefit of secure funding: the ability to attract and retain quality staff. Agencies with a steady revenue stream can hire engineers for the long term—and pay their workers better. Public employees then enjoy the prospect of predictable work, professional careers, and higher status. They are also more inclined to accumulate experience within a single agency and pass that knowledge on to new workers moving up in the ranks.

Reinvigorating the Civil Service

Secure funding is only part of the larger question of how to get the most infrastructure for the buck. In the eyes of many people, civil service is so bloated and inefficient that public works ought to be taken out of the public sector altogether.

Though it may not be uniquely American to distrust government, we pride ourselves on our well-developed disdain for public institutions. But although corruption and laziness no doubt exist (as they do in the private sector), the most commonly heard solution—privatization—is hardly a sure-fire remedy.

The private sector certainly has an important role to play in infrastructure investment and planning; most public works construction is contracted out to private firms, and public-private enterprises now successfully operate waste facilities across the country. But public employees can actually be more productive and efficient than contracted workers. Among other reasons, they tend to be more specialized than workers in general contracting firms, who might do road repair one week and building construction the next. Repaving a mile of New York City street in the early 1980s cost $32,000 when performed "in house" and $57,000 when contracted out.

According to the Economic Policy Institute's report "The Emperor's New Clothes," analyses demonstrating the benefits of privately run services often omit public subsidies of the new private enterprises. The report argues that privatization is too often a euphemism for a taxpayer-subsidized corporate monopoly of a traditionally public service, with little or no cost savings. And, the report notes, there are obvious liabilities in replacing the goal of public service with profit maximization. As David Osborne writes in *Reinventing Government*, "Those who advocate [privatization] on ideological grounds—because they believe business is always superior to government—are selling the American people snake oil."

Indeed, the growing debate over the merits of public versus private control misses the point. The central issue, Osborne argues, is really competition versus

PHOTO: KEVIN KIRWIN/MASSACHUSETTS WATER RESOURCES AUTHORITY

monopoly. The trouble with public works departments is that, like any monopoly, they tend to replace the goal of public service with self-preservation. Osborne looks to "public entrepreneurs" who are fed up with rule-bound bureaucracies. Injecting a dose of competition into moribund agencies, he argues, can boost service, cut costs, and improve worker morale and productivity.

When the citizens of Phoenix voted to privatize garbage collection in 1978, for example, the Public Works Department opted to compete directly with private companies for collection contracts. Drivers helped redesign routes and work schedules to boost efficiency. Labor-management "productivity committees" identified and implemented innovations. A new accounting system monitored precise per-household costs. And a suggestion program gave employees 10 percent of savings, up to $2,000, for their cost-cutting ideas.

By 1988, the city agency had won back all five collection districts. Solid waste costs dropped 4.5 percent annually over 10 years, while employee morale soared. Phoenix has also expanded such public-private competitive bidding to landfill operations, custodial services, parking lot and golf course management, street sweeping, and concessions. The first decade produced combined savings estimated at $20 million.

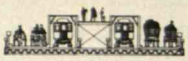
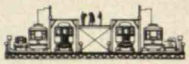
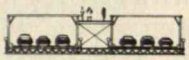
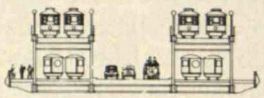
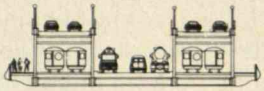
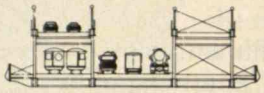
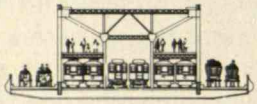
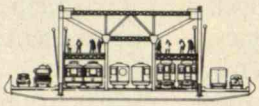
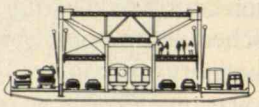
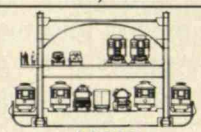
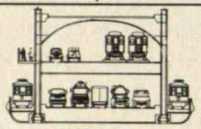
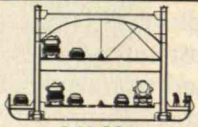
Unfortunately, would-be public entrepreneurs often find themselves caught in a tangle of bureaucracy. In New York City, scandals in the public sector have prompted new layers of oversight and review to prevent the theft of public funds. But the oversight processes can end up costing more than the problems they are designed to prevent. A recent study by the New York Building Congress concludes that "the City's procedure of capital improvement is as much in need of overhaul as the physical infrastructure itself." Its primary recommendation: rather than add layers of oversight, push power down the bureaucratic ladder and give project managers and resident engineers the authority to do their jobs.

"The Mayor's Private Sector Survey," written by a consortium of New York companies, offers similar advice: replace the current system of multiple-agency oversight with a single project manager responsible for an undertaking from beginning to end. "The private sector," the report notes, "has learned that without focused responsibility and accountability from inception to completion, capital projects cannot be efficiently managed and costs and schedules escalate." The report identifies $3.8 billion in savings that could spring from this central proposal.

Like secure funding, bureaucratic reform can make public agencies more attractive to top professionals. Faced with a tedious hiring process, the smartest prospective recruits simply find other work by the time bureaucracies churn through the required paperwork. Likewise, frustration with bureaucratic tie-ups often forces experienced workers and managers to abandon public service. This need not be the case: in Japan, public servants are among the most respected professionals, and even in the United States—before the days of too many cooks—public works departments drew the country's leading engineers.

Could private-sector workers have done this job for less? Not necessarily, according to several studies showing that public works employees can actually be more productive. Removing layers of oversight, rather than embracing privatization, may be the key to cost-effectiveness.

PHOTO: FRANK SITEMAN

	FULL TRANSPORTATION OPENING	PEAK YEAR	PRESENT
BROOKLYN BRIDGE 1883	 341,000 (1902)	 426,000 (1907)	 178,000
MANHATTAN BRIDGE 1909	 229,000 (1917)	 703,000 (1939)	 360,000
WILLIAMSBURG BRIDGE 1903	 227,000 (1910)	 505,000 (1924)	 240,000
QUEENSBORO BRIDGE 1909	 44,000 (1910)	 326,000 (1940)	 248,000
TOTAL	841,000	1,960,000	1,026,000

New construction—whether of roadways, water mains, or sewage treatment plants—is not always the most efficient way to upgrade infrastructure. "Improvements" on New York's East River bridges have actually brought declines in the number of people crossing annually.

Promoting System Efficiency

It will surprise no one that inefficient public works bureaucracies produce inefficient public works. In their single-minded pursuit of new construction, agencies have often overlooked alternatives that would have cost less or done the job more effectively, or both. In transportation, this attitude has led to more roads instead of better roads, and to roads instead of more efficient modes of travel. New York City's four East River bridges lost much of their carrying capacity as transit lines were replaced with asphalt in the 1940s and '50s. The Brooklyn Bridge is the starkest example of dwindling performance. In 1907, with two subway lanes, two trolley tracks, and two lanes for horse-drawn carriages, the bridge could carry 426,000 people a day. Now, with six lanes of vehicle traffic, the bridge carries less than half that number. Clearly, the basis for policy decisions should be system efficiency—how quickly and inexpensively we can move the most people.

As its name implies, the new $155 billion federal Intermodal Surface Transportation Efficiency Act has adopted this approach as a chief policy goal. Among other measures, it concentrates federal spending on the roads that are most important to interstate travel and that connect with mass transit, and it funds the development of promising efficiency-boosting technologies such as intelligent vehicle/highway systems and magnetically levitated trains.

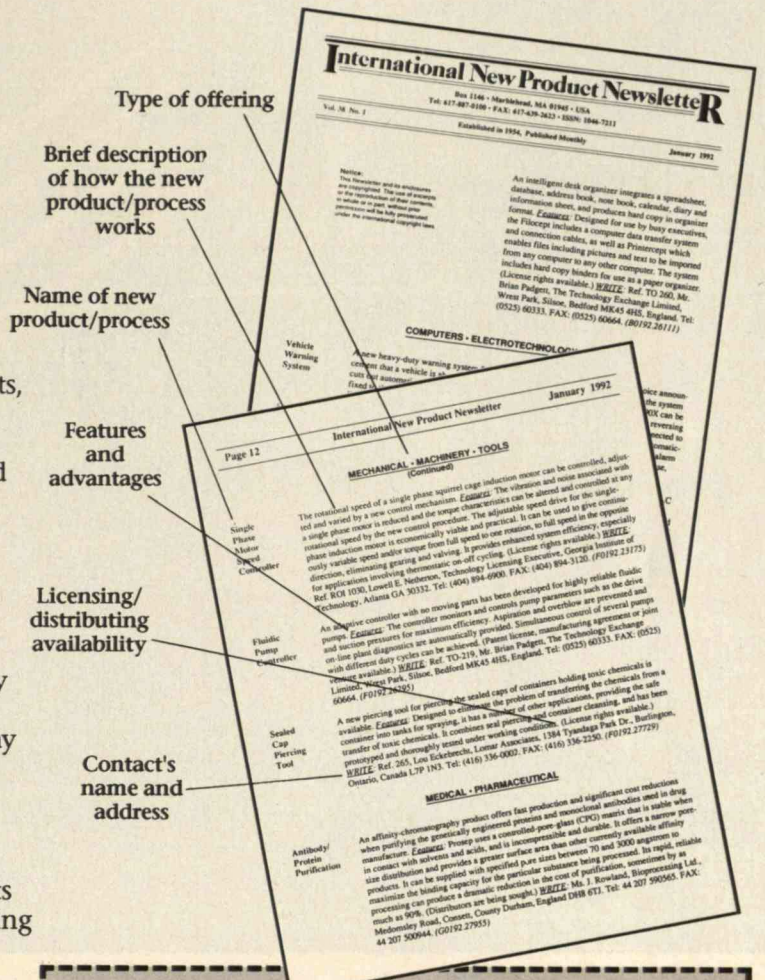
The goal of efficiency applies equally to other areas of infrastructure. In many cases, traditional concrete-and-steel engineering solutions can be replaced with alternative management techniques. For example, the New York City Department of Environmental Protection is examining ways to improve water quality without making huge investments in filtration plants. Possibilities include strategic land purchases to preserve watersheds and removal of leaking septic tanks near streams. And much as electric utilities now offer demand-reducing services and products to offset the need to build new power plants, water authorities could measure the cost of boosting the efficiency of water use (say, by installing gray-water systems and low-flow toilets and shower heads) against building new water supplies, mains, and treatment plants.

In fact, efficiency will have to be the watchword for solving the infrastructure crisis on all levels—funding, organization, planning, and implementation. To be sure, public works legislation now under consideration could ease some of the demand on state and local coffers. A plan sponsored by Sen. Howard Metzenbaum (D-Ohio) and others, for example, would divert $150 billion in defense outlays to "social investments," including $100 billion for infrastructure. And Sen. Ted Kennedy (D-Mass.) has proposed spending $210 billion on infrastructure—as well as social and environmental programs—over seven years. But even if they become available, these funds will only partly cover the cost of restoring vital systems. Public agencies will still need to innovate, raise efficiency, and stretch tight public funds. Luckily, they have ample room for improvement.■

PHOTO: NEW YORK CITY DEPARTMENT OF TRANSPORTATION

100 of technology's newest and most interesting products and processes from around the world are in the INPN.

Every month.



Respected and reliable.

Each month since 1954, the International New Product Newsletter (INPN) has been the key source of new technology and business opportunities for scientists, engineers, consultants, entrepreneurs, small businesses, libraries and Fortune 500 R&D departments smart enough to use the most up-to-the-minute technological and commercial information available.

Helpful and unique.

To expedite your search for new technology our editors screen over 15,000 new products and processes a year from the USA, U.K., Europe, Eastern Europe and the Far East. They report only on those items which have immediate practical and commercial potential. Many of the items may be worth $10,000,000 or more to the right party.

Ongoing technologies.

Receive a continuous source of data on new products that can help your company diversify its activities by manufacturing products or by utilizing state-of-the-art technology under license or by acting as an exclusive sales agent or distributor.

The International New Product Newsletter brings you advance news of business and venture possibilities from a wide variety of sources in many different areas including:

- **Chemicals and Chemical Processes**
- **Computer Hardware and Software**
- **Consumer Products**
- **Electrical, Electronic and Electromechanical**
- **Industrial Equipment**
- **Materials Forming and Production Methods**
- **Measuring, Testing and Control Devices**
- **Mechanical Fabrications**
- **Medical**
- **And more**

Yes! I'd like to subscribe to the International New Product Newsletter for 1 year (12 issues).

Name _____

Company _____

Street _____

City _____ State _____ Zip _____

Visa/MasterCard # _____ Exp. _____

Tel. # (Required for Credit Card orders) _____

Enclosed please find my check in US Dollars for:

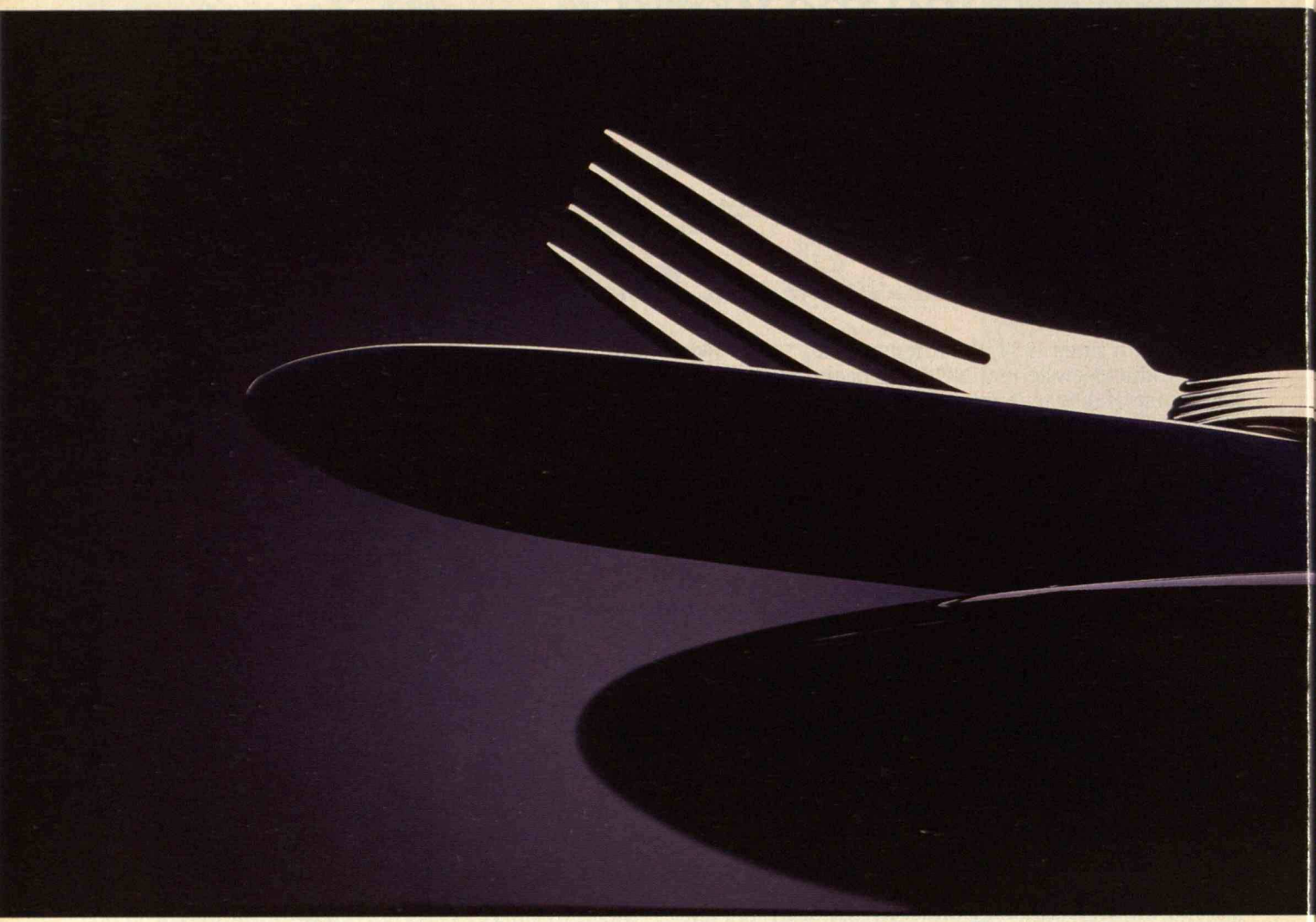
US & Canada: $175 _____ (US $ drawn on a US bank)

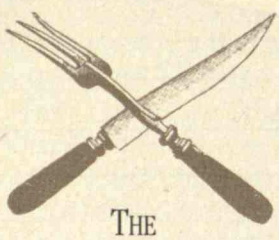
Elsewhere: $250 _____ (US $ drawn on a US bank)

Make checks payable to and mail to:
International New Product Newsletter,
P.O. Box 1146, Marblehead, MA 01945 USA
Or Phone/Fax (617) 639-2623

International New Product Newsletter is published by Transcommunications International

How Designs Evolve





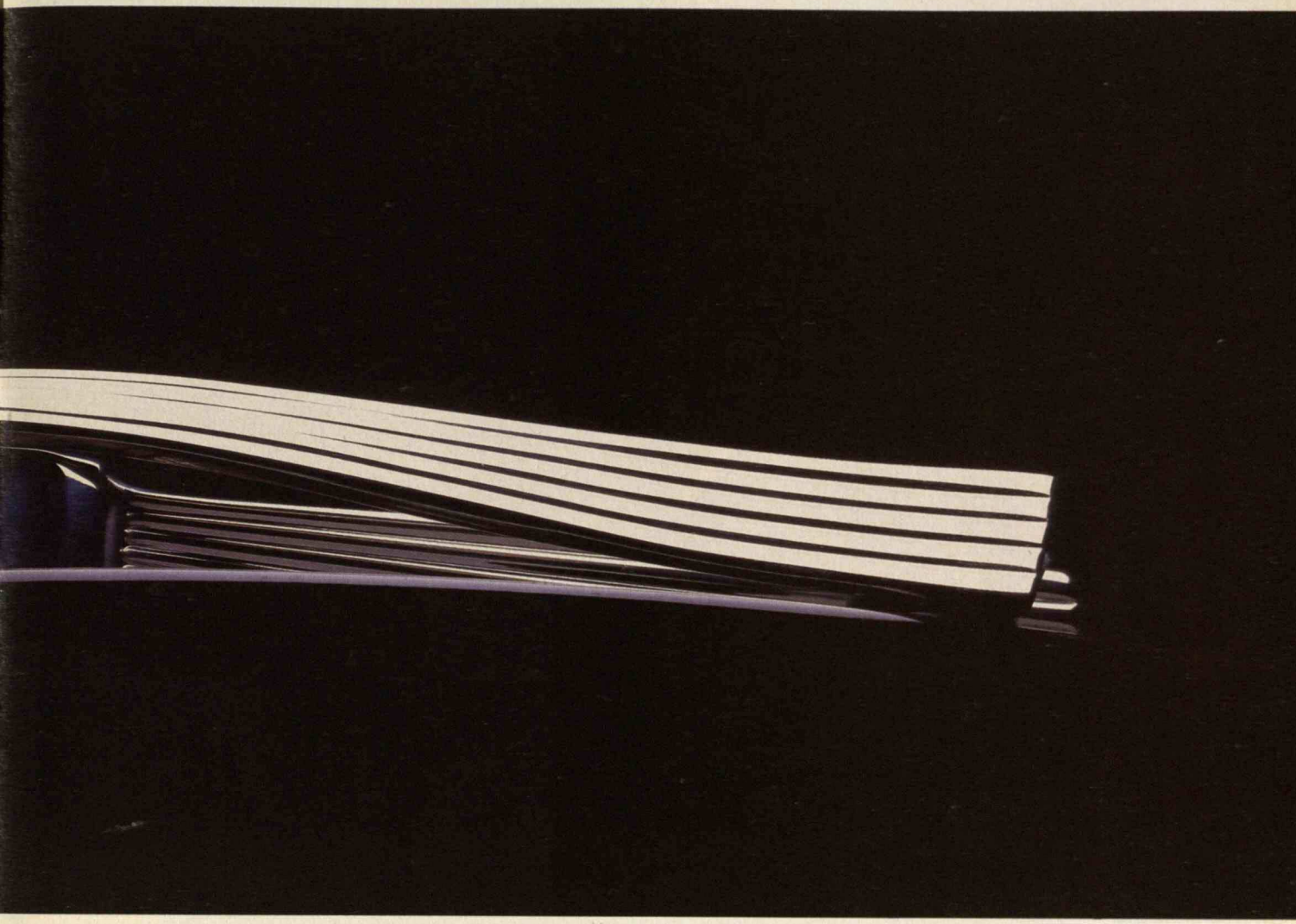
THE SIMPLEST OF OBJECTS REVEAL THE INEXORABLE FORCES OF TECHNOLOGICAL CHANGE.

Understanding the nature of design is essential to success in manufacturing. By looking at the evolution of some of the simplest engineered tools, one can gain insight into the process of how all devices, from eating utensils to complicated technologies such as supercomputers, change into forms well suited to their users' needs.

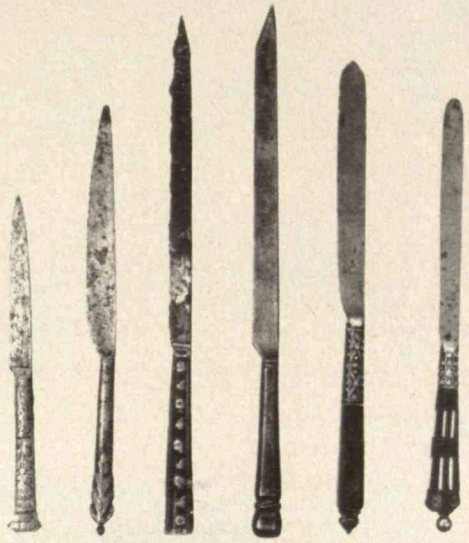
Consider the knife and fork. Well into the seven-

By Henry Petroski

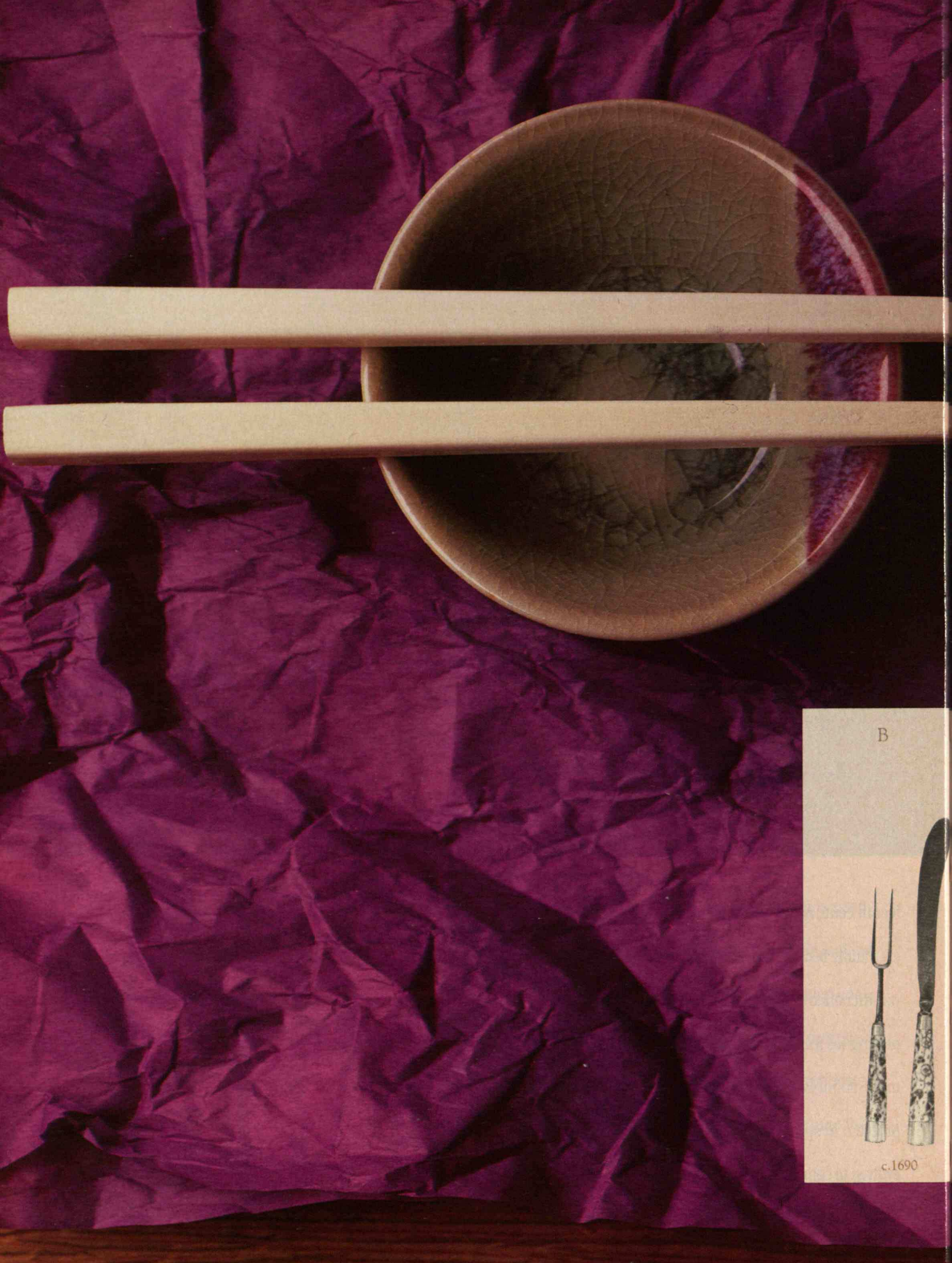
Photographs by MAS Photography

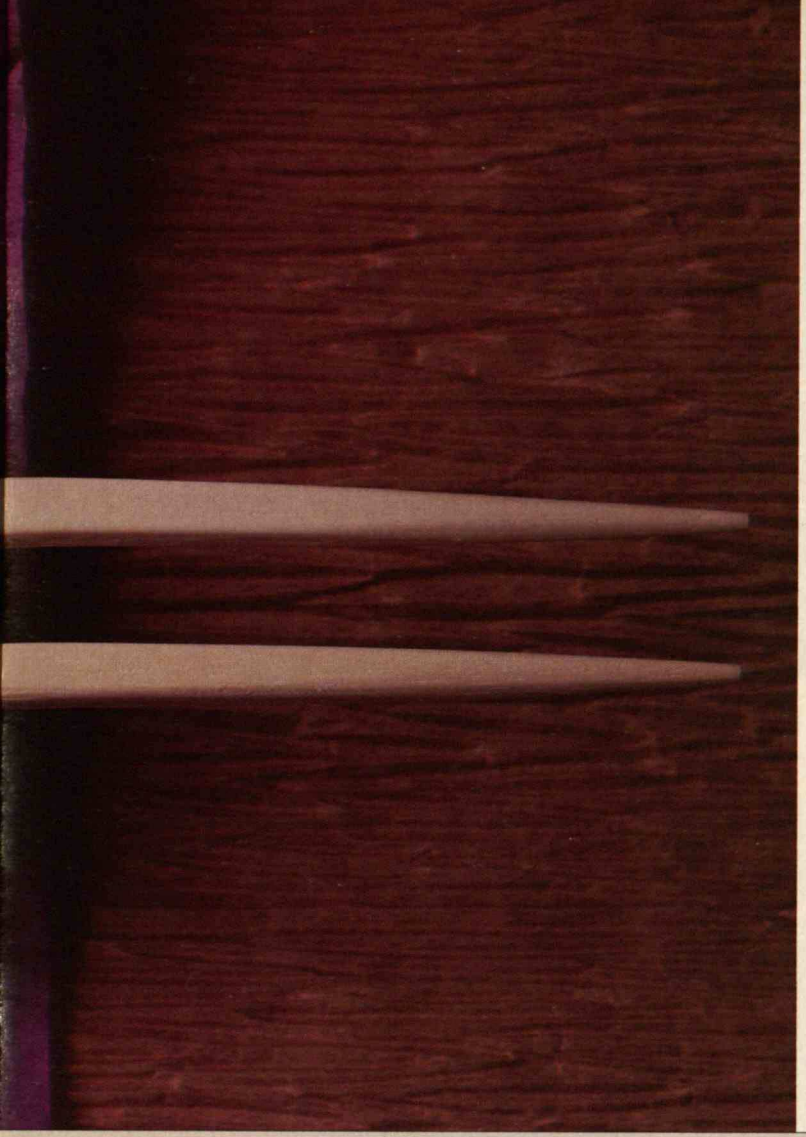


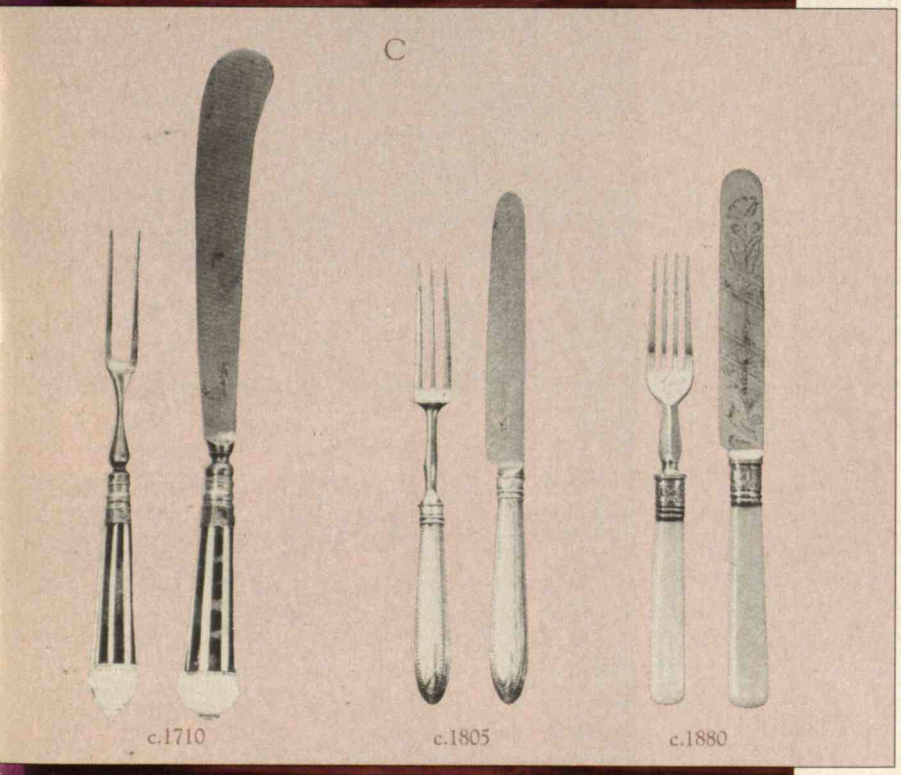
teenth century one pointed knife sufficed, but diners eventually became more refined: It is said that Cardinal Richelieu's disgust with a dinner guest's habit of picking his teeth with the point prompted the development of knives blunted at the tip (A). This presented a problem in spearing food, and so the two-tined fork evolved to complement the blunted knife. But this fork had shortcomings as tableware. Small, loose pieces of

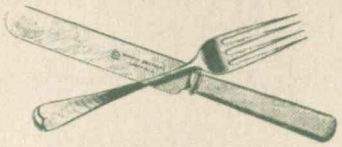


A c.1530 c.1530 c.1580 c.1580 c.1630 c.1633


B
c.1690







food fell through the space between the tines, and the ease with which speared meat could be removed from two tines made its retention on the fork difficult. One answer was to make the knife tip bulbous and curved, so that food could be heaped onto it and delivered easily to the mouth (**B**). Another solution was to introduce more tines to the fork (**C**).

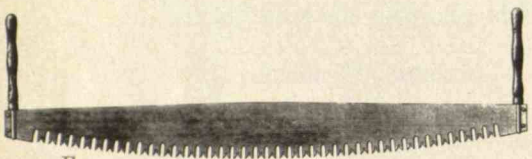
Of course, Oriental diners were no more pleased with sticky fingers than Europeans were before they started using knives. The development of chopsticks demonstrates different and culture-specific solutions to the same design problem. Form does not follow function; form follows the failure of existing things to function as well as an inventor can imagine. And imagination breeds diversity.

HENRY PETROSKI is chair of the Civil and Environmental Engineering Department at Duke University. *This essay is adapted from* The Evolution of Useful Things *(copyright 1992 by Henry Petroski), published by Alfred A. Knopf in December 1992.*

ILLUSTRATIONS:
A, B, C,: FROM *A CHRONOLOGY OF CUTLERY*, COURTESY OF SHEFFIELD CITY MUSEUM, ENGLAND; H, I: FROM *ENGINEERING AND THE MIND'S EYE*, EUGENE FERGUSON, MIT PRESS, 1992.

Specialized tools of the crafts and trades have proliferated throughout history in part because different craftspeople have evolved various solutions while working with devices perceived to limit achievement or efficiency. For example, in *De Re Metallica*, a 1556 monograph on mining, Georgius Agricola systematically recorded the methods and tools of that trade. One illustration shows a silversmith at work on raw metal, and into a nearby stump is stuck what looks like a pair of shears, one of its handles bent into an L shape (**D**). The tool's modified form provided leverage and enabled the silversmith to easily cut a piece of metal without a helper.

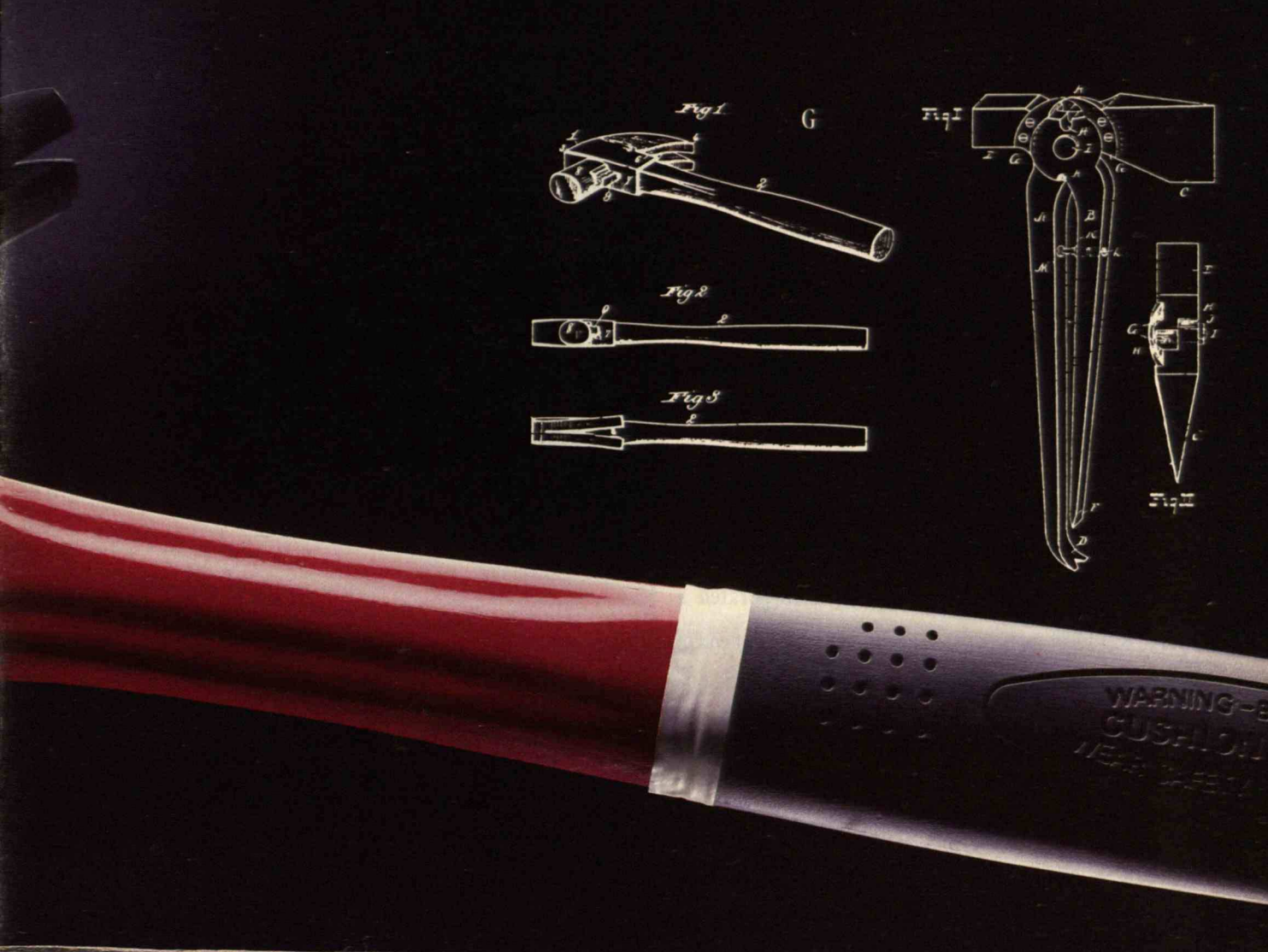
A wide variety of saws has developed in response to different users' needs. For instance, the long and relatively wide-bladed saw with two handles, designed to be operated by one sawyer on each end, was designed to cut down large trees (**E**). But after being used to fell a tree and cut it up into logs, this saw could not easily cut them lengthwise into boards. Before the days of steam power, a system developed in which two sawyers, one of whom worked from above the log and the other of whom worked from below, used a framed instrument with handles set crosswise to a saw blade (**F**). An extended top handle relieved the top sawyer from stooping with each stroke and kept fingers from becoming caught. The bottom sawyer's handle evolved into one that was easily removed when the saw had to be pulled out for sharpening.



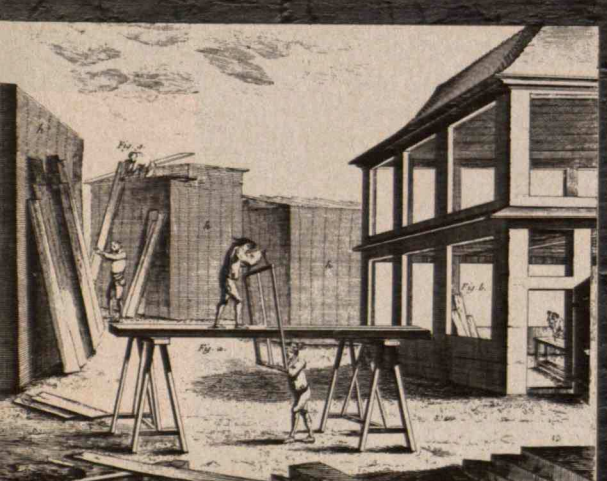
E

Hammers have been a frequent focus in studies of technological form. *The Hammer: The King of Tools*, a 1989 book by Ron Baird and Dan Comerford, contains more than 100 pages of photographs, typically showing 10 or 12 styles per page, of odd and unusual hammers and hammer heads. While most hammer handles are as unremarkable as the one shown at the left of Fig.**G**, which depicts two hammers patented in 1898, some, such as the one on the right, have

D

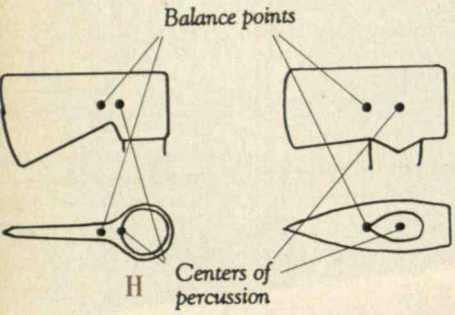


F

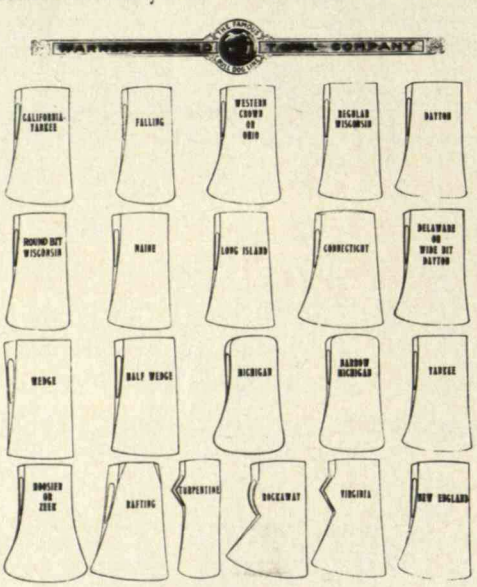


distinctive handles intended to perform specialized functions, such as chiseling or use as a crowbar.

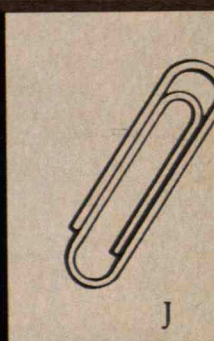
Axe designs have also evolved in accord with various users. By 1700, some American-made axes looked modestly different from their European ancestors, in that they incorporated a poll—the blunt end of an axe head that projects from the back side of the handle (H). This feature stabilized the axe head and enabled it to pack a bigger wallop. The two-edged axe was developed at the end of the eighteenth century. Sharpening a one-edged axe might not be inconvenient for a farmer working near a sharpening stone, but it could be for a woodsman working far from home base. Many local variations in the axe head developed in the United States during the 1800s, perhaps to accommodate different trees in various parts of the country (I). The proliferation of styles was such that manufacturers came to offer more than 100 items.



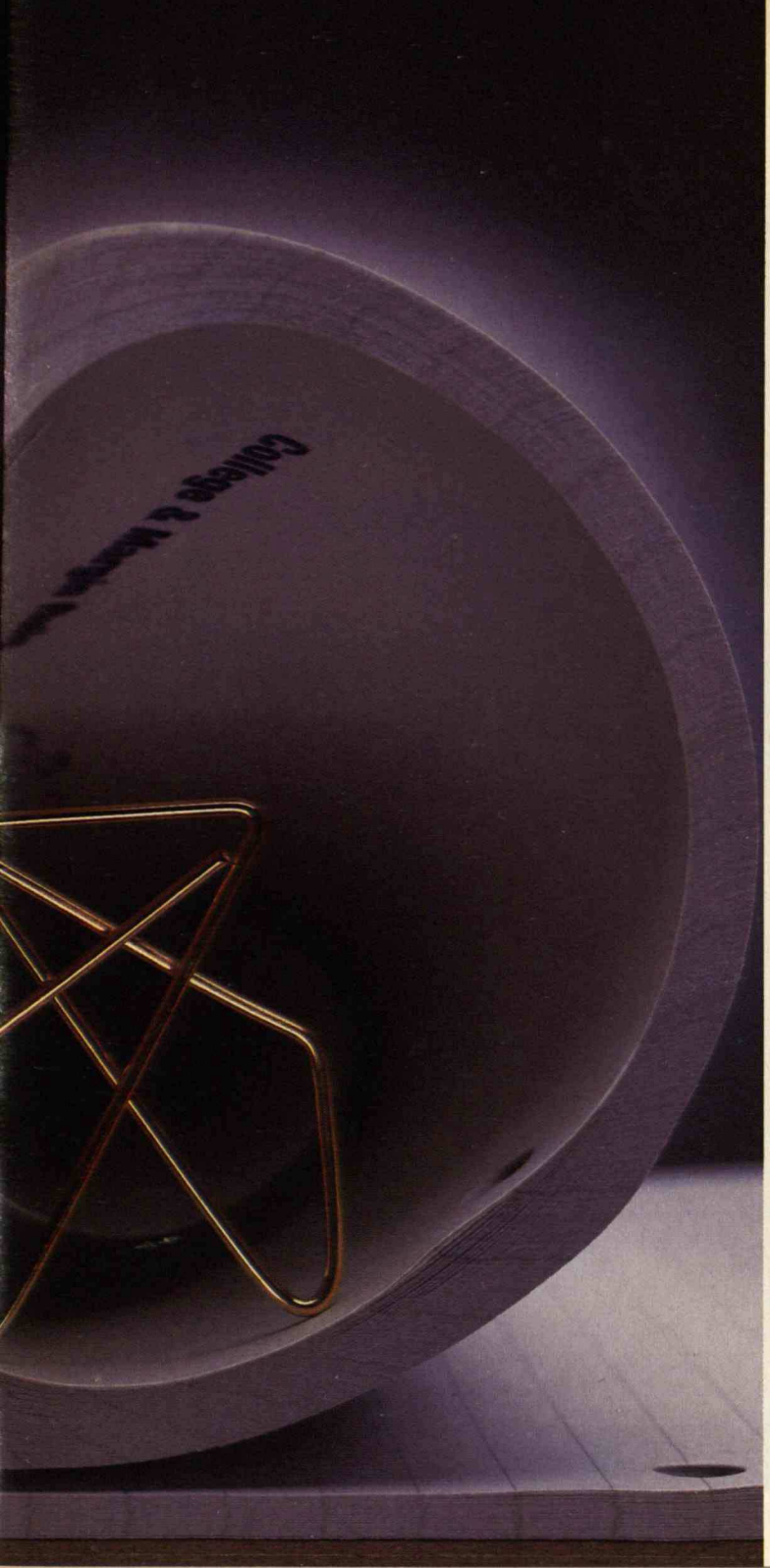
H

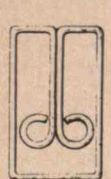


I

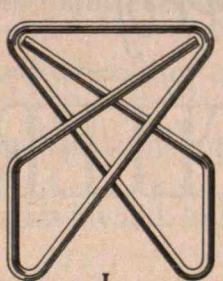


J

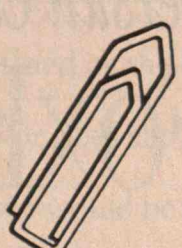




K



L

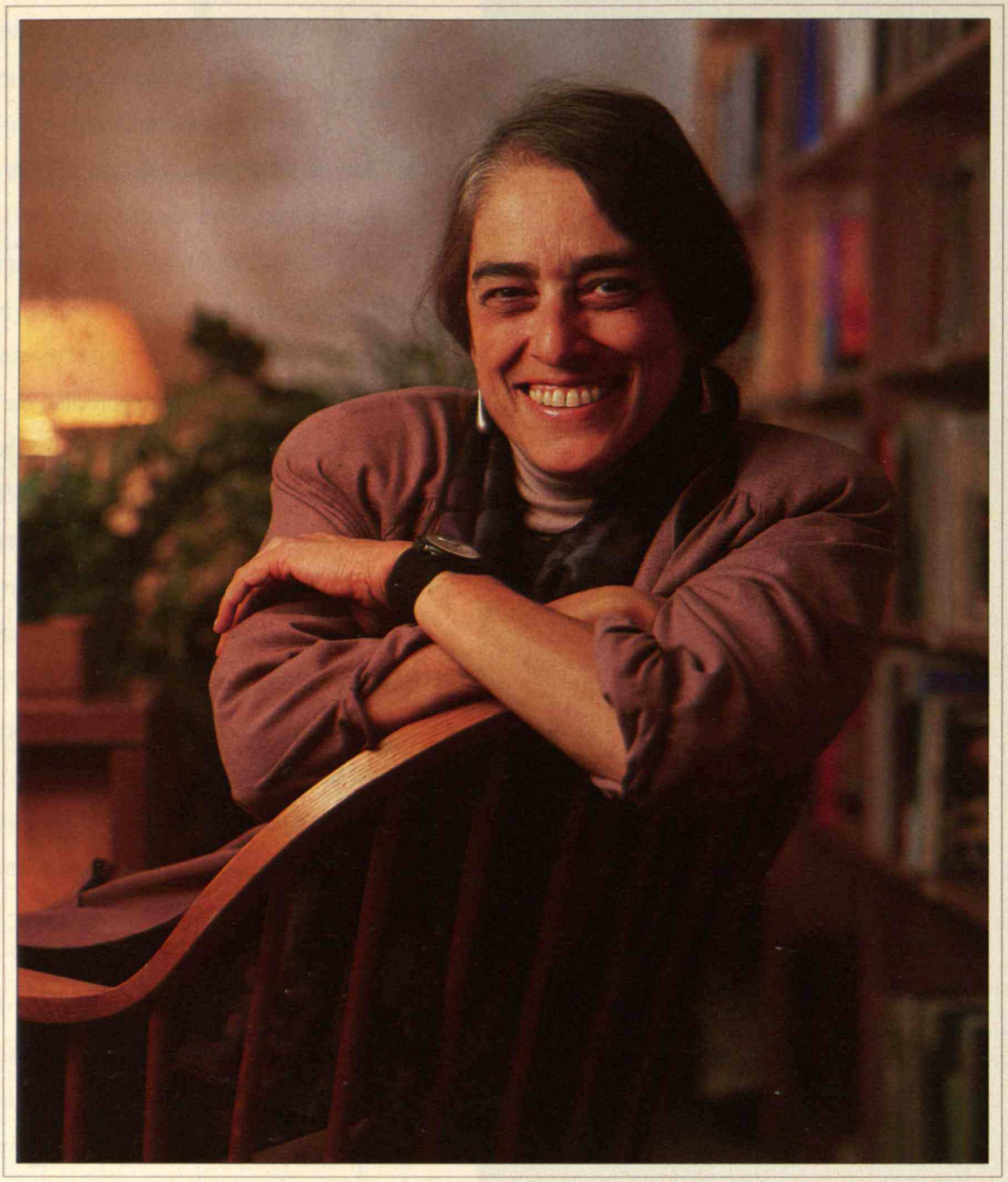


M

A plethora of paper-clip patents has been driven by the same forces that shape today's most complex systems—the continued identification and elimination of shortcomings. The classic double-loop shaped style, the Gem paper clip(**J**), was introduced around a century ago and became popular because it is relatively easy to attach and remove, lies relatively flat, and stays relatively put. But the two-eyed Owl clip(**K**) does not tangle as easily with other clips. The Ideal clip(**L**) holds much thicker piles of paper and can be attached to them with greater ease. Some users of the Gothic clip(**M**), such as librarians who attach cataloging material to title pages, swear that this device, with the wire ends set close to the clip's rectangular end, is much less likely to do damage when removed. Plastic competitors offer color, and their non-magnetic property means that they can be used with computer disks.

The evolution of devices feeds on comparisons: in some way each new instrument is better—more efficient, more attractive, less expensive, less bulky—than the old one it replaces.

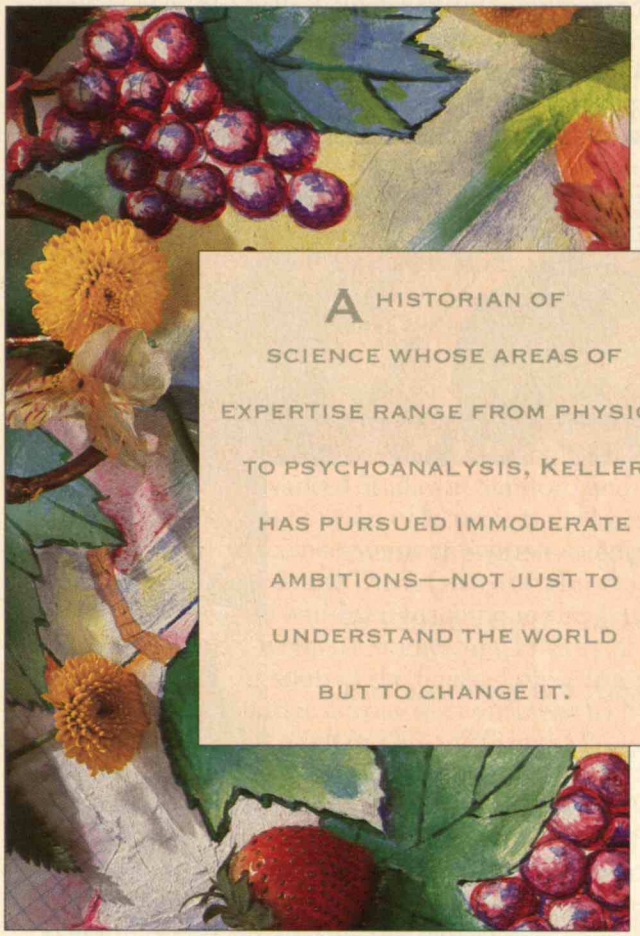
Although designers speak of "perfected" devices, nothing is in fact perfect. Inventors are technology's severest critics, with their patent applications routinely pointing out the shortcomings of the state of one art or another. Yet inventors are technology's supreme optimists, for they see how wrongs may be righted. Thus the vast number of inventions that exist in the world today ensure that there will be ever more tomorrow. The reactionary call to leave well enough alone is futile, for the advance of civilization itself has entailed the successive correction (albeit sometimes overcorrection) of failures, with new, improved versions coming in all shapes and sizes. ❑



The Controversial Career of EVELYN FOX KELLER

By Beth Horning

BACK in the mid-70s, when Evelyn Fox Keller was toiling away as a scientist, a question occurred to her. How much of science is bound up with people's ideas about masculinity, and what would the discipline be like if, somehow, it weren't? She says such musings upset her "entire intellectual hierarchy," and by 1985, when she published her book of essays *Reflections on Gender and Science*, they were upsetting a good cross-section of everyone else's.



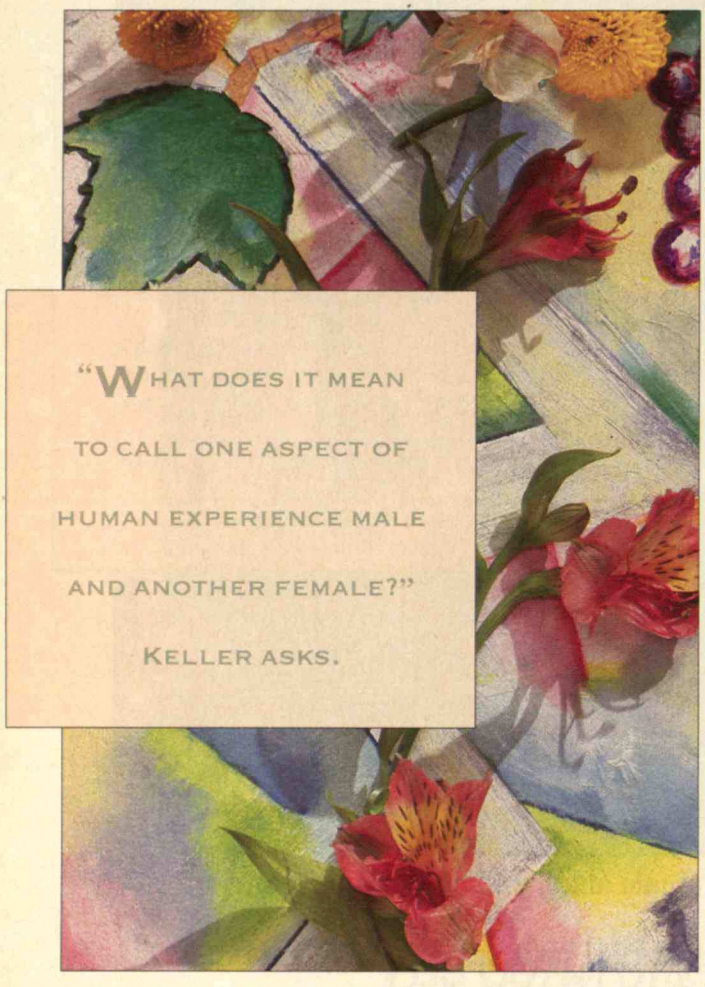
A HISTORIAN OF SCIENCE WHOSE AREAS OF EXPERTISE RANGE FROM PHYSICS TO PSYCHOANALYSIS, KELLER HAS PURSUED IMMODERATE AMBITIONS—NOT JUST TO UNDERSTAND THE WORLD BUT TO CHANGE IT.

Today Keller's work remains controversial despite widespread acclaim, which most recently took the form of a coveted MacArthur Award. But what she actually says is different from what some people assume. To be specific, she does not think women are predisposed to do a different kind of science from men. Rather, she has examined science as it's done by scientists in general, male and female alike, and come to the conclusion that many supposedly masculine qualities, such as objectivity, become distorted when they are defined as the opposite of supposedly feminine ones, such as subjectivity. Nor does she claim that science as it's currently practiced is invalid. Indeed, she would be canceling out a large portion of her

PHOTOGRAPH: DAVID OXTON; ILLUSTRATIONS: WENDY BRAUN

adult life if she did that: holder of a Harvard PhD in theoretical physics, Keller has spent long, hard years working within traditional science, and she has amassed impressive credentials. She has published original work not only in theoretical physics but in molecular biology, writing her dissertation under the supervision of renowned Harvard molecular biologist Matthew Meselson. In the field of mathematical biology, which creates models of biological processes, several of her papers have become classics.

Not surprisingly, therefore, Keller critiques science with an eye to making it better—that is, more productive. One of her strongest beliefs is that the best hope for such productivity lies in expanding the range of thinking styles available to scientists. Her aim, as stated in *Reflections,* is the "reclamation, from within science, of science as a human instead of a masculine project."



Those ideas also inform *A Feeling for the Organism*, her 1983 biography of the maverick geneticist Barbara McClintock, as well as her new book, *Secrets of Life, Secrets of Death*, and the several essays she has published in the last few years. But as Keller's work has evolved, her thinking has deepened, and the reaction to *Reflections*, her most talked-about work, has clearly had something to do with it.

BETH HORNING is an associate editor of Technology Review.

Toward Diverse Conceptions of Mind

The complex reasoning behind Keller's arguments in *Reflections* draws on scholarship not only in science but also in psychology and history. What she essentially does is to trace the development of scientific thought from Plato to the present day, making a special stop in seventeenth-century England, the site of what has come to be known as the scientific revolution. There the Royal Society was established in 1662, institutionalizing a view that had been centuries in the making: that nature was subject to mechanical laws, and that those laws could become intelligible to the observer only through antiseptically disinterested examination. The competing view of the "hermetic" philosophers—namely, writes Keller, that nature is "suffused with spirit" and that an understanding of it requires "the joint and integrated effort of heart, hand, and mind"—fell out of favor.

But if the seventeenth century was a time intellectual change, it saw political upheaval as well. Most significantly, people's ideas about gender roles "were becoming polarized in ways that were eminently well suited to the growing division between work and home required by early industrial capitalism." And that polarization became an essential part of the Royal Society's new, mechanical science: Henry Oldenburg, secretary of the society, proclaimed that its intention was "to raise a Masculine Philosophy . . . whereby the Mind of Man may be ennobled with the knowledge of Solid Truths." Women were excluded from the society and relegated to the domestic sphere.

So began the dearth of women in science that a legion of twentieth-century affirmative action programs would attempt to redress. However, the point Keller makes in invoking all this history is much broader: not only have actual flesh-and-blood women been shut out of scientific professions for hundreds of years, but the characteristics women are presumed to embody are seen as grave liabilities. Science, she notes, has evolved into an especially prominent stronghold of "the deeply rooted popular mythology that casts objectivity, reason, and mind as male, and subjectivity, feeling, and nature as female." Yet objectivity and subjectivity, reason and feeling are qualities all people share just by virtue of being human, and to her way of thinking, that raises a rather serious question. "What does it mean to call one aspect of human experience male and another female?" she asks.

Keller feels it means that those aspects of human experience themselves become distorted. She illustrates this mainly by investigating the concept of objectivity, which is the cornerstone of science. Objectivity defined as intrinsically "male" and utterly free of any hint of

subjectivity is an unattainable goal, she says. Scientists, being human, cannot even hope to cleanse themselves of their hopes, fears, and desires; their arrogant belief that they are doing so results in a restricted understanding of the world. The truths discovered in the lab are undeniably true, but their discoverers fail to grasp that other truths might also be true, and that other questions or methods of investigation might be equally worthwhile.

To find a more useful conception of objectivity, Keller taps her reading in psychoanalytic theory and suggests that the quality might be seen as a counterpart of psychological autonomy—of one's sense of self, in other words. Just as "autonomy too sharply defined cannot encompass the emotional and creative experiences that give life its fullest and richest depth," so too, objectivity, premised on a sharp division between the observer and the observed, cannot yield our best understanding of the natural world. To put it another way, she speculates that the same kind of rigidity that often hampers emotional development also hampers scientists' efforts to understand nature.

Thus she advocates an ideal of "dynamic objectivity," in which the boundaries between observer and observed, like those between self and other, are recognized as irrevocably elusive—as fluid and dynamic rather than fixed and static. This would, on the one hand, allow for the fact that no scientific work can provide anything but an imperfect description of nature and, on the other, give scientists license to see their inevitable subjective feelings as a resource rather than a drawback. No one would be able to sustain the fantasy that nature is completely knowable and that human beings are capable of completely knowing it. But the findings that might become possible could more than compensate for that loss.

She explains what she means through the example of Barbara McClintock, who in 1983, at the age of 81, won a Nobel Prize for her discovery that the genes in corn are capable of jumping from one chromosomal site to another. For years most of her colleagues dismissed that idea, convinced that genes were relatively simple and static and dictated the development of organisms in a straightforward manner. But McClintock adhered to her own more complicated notions about how genes might operate, as well as to her conception of the natural world as more wondrous and varied than human beings can ever know.

Her way into that world was to pay unusually close attention to the exception. "The important thing is to develop the capacity to see one kernel [of corn] that is different and make that understandable," McClintock noted. And with that deep respect for the odd single kernal, the incorrigible kinks in nature, went a "feeling for the organism" and a willingness to "listen to the material"—phrases she returned to again and again in telling Keller about her work. McClintock, in short, depended upon engaging her subject matter on a personal level. "I wasn't outside," she said, describing one of the more exciting moments in her studies. "I was down there, I was part of the system . . . . I actually felt as if I was right down there and [the chromosomes] were my friends."

Yet even though the McClintock story points to a model for a different science, it also reveals some strengths of the current system. McClintock's idiosyncracies may have led other scientists to ignore her for long stretches, but when it became obvious to them that she was right about some things, they recognized it. Furthermore, she always had a job and a lab, as well as a handful of supporters—the minimum requirements for continuing her work. All of which suggests that in practice, science is far more pluralistic than it's made out to be. A chief goal of Keller's is to open science up to even more pluralism—a healthy science, she writes, is one that makes room for "diverse conceptions of mind and nature, and correspondingly diverse strategies."

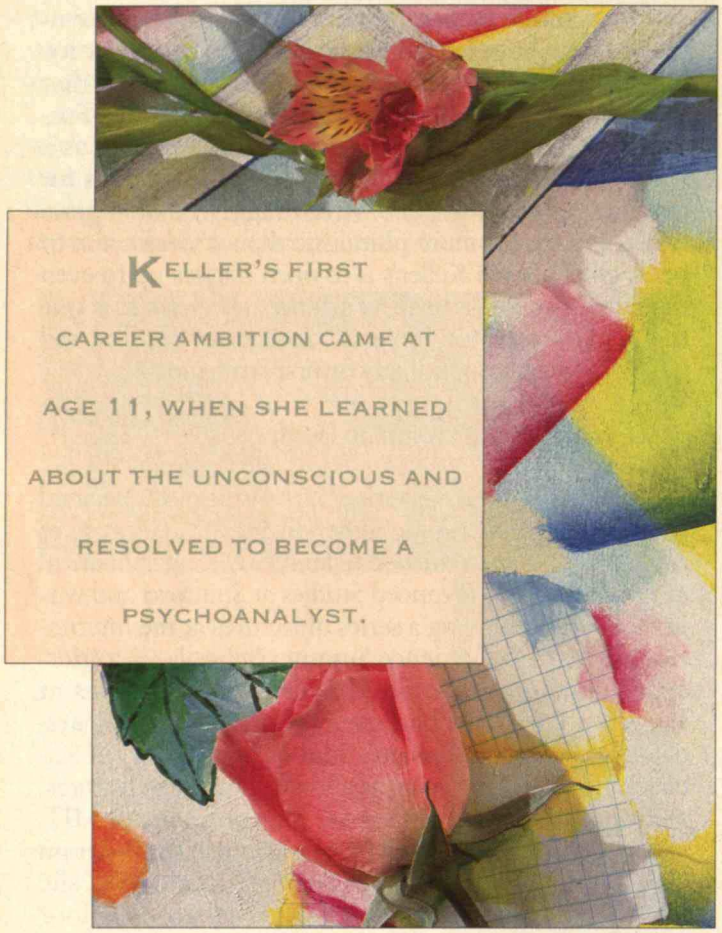
To Physics through Freshman Comp

When I interviewed Keller late last summer, she seemed to be in the midst of some rather diverse strategies of her own. She had just returned from a year-long sabbatical at the Center for Advanced Studies at Stanford and was in the middle of giving a series of lectures at the International History-of-Science Summer School—a conference held that year at the University of California at Berkeley, where she had been teaching in the departments of Rhetoric, Women's Studies, and History of Science since 1988. As soon as she finished those lectures, she was going to move across the continent to MIT, where she now holds a full professorship in the Program in Science, Technology, and Society. Meanwhile, she had a new book in press. Her shadowy ground-floor office at Berkeley was full of half-packed boxes, and the tall gray metal bookcases held stacks of galleys bristling with yellow post-it notes.

Not that she was particularly frantic. In fact, she even seemed relaxed. Her dark, slightly graying hair was neatly pinned up behind her head, and her flowing dress, dangle earrings, and waist-length necklace of black beads bespoke a casual, almost bohemian style of living, the kind common in people who've learned to take a certain amount of chaos in stride. She tucked her long legs under her ancient, squeaky office chair and talked easily, laughing at herself from time to time but giving the serious matters in both science and life—of which, for her, there are many—their due.

As I quickly discovered, the interdisciplinary sweep of Keller's work reflects a lifetime of evolving concerns, and for a long while, science wasn't even among them. Born in 1936 to poor, hard-working Russian Jewish immigrant parents who never went to high school, she got most of her intellectual stimulation from the New

York City public school system and didn't have anything like a career ambition until she was about 11. That was when her sister Frances, now a professor of political science at the City University of New York, came home to Queens on a visit from college and explained the idea of the unconscious, which she had just learned about.



KELLER'S FIRST CAREER AMBITION CAME AT AGE 11, WHEN SHE LEARNED ABOUT THE UNCONSCIOUS AND RESOLVED TO BECOME A PSYCHOANALYST.

Evelyn was enthralled. The mind was revealed to be more fascinating than she had ever suspected, full of dreams to decipher, arcane mysteries to explore. She resolved to become a psychoanalyst.

She was still intent on that goal when she graduated from high school, but by then her other sibling—Maurice, or Maury, a biologist who currently teaches at MIT—was trying to seduce her into science, feeding her books by popular science writers Isaac Asimov and George Gamow. Eleven and a half years older, Maury had left home when his younger sister was a small child and so had seen little of her when she was growing up, yet he began to pay real attention to her once she hit adolescence. "He decided that I was talented and needed looking after," Keller says. "He'd swoop down to do that from time to time." In addition to exposing her to Asimov and Gamow, for instance, he talked her parents into getting her braces, which was unheard of in working-class families at the time. "He had this dentist friend from the army who had persuaded him that straight teeth were crucial," she remembers.

It turned out that the braces worked but the books didn't, at least not at first. Just how much dust Evelyn was allowing to collect on them became clear during her freshman year at Queens College, when she took a course in calculus mainly because it seemed like a prudent thing to do. "Why don't you major in math?" asked her professor, who, having identified her as one of his brightest students, took it upon himself to lure her away from psychology. "Because I don't want to be an accountant," she answered. "Well, then," he countered, overlooking her ignorance, "why don't you major in physics?" To which Evelyn replied, "What's that?"

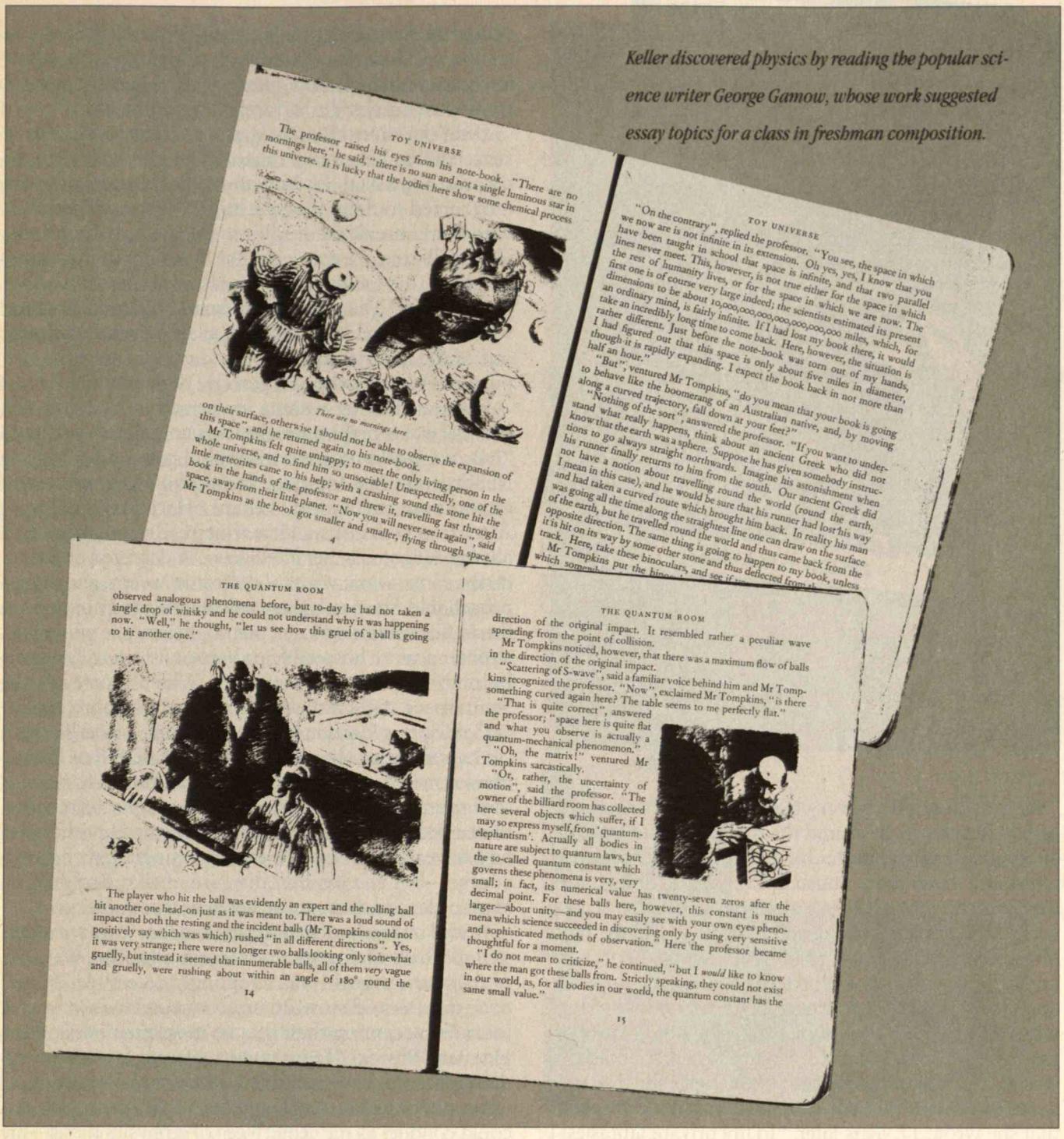
She was soon to find out—though in freshman composition, of all places. Try as she might, she could never achieve anything higher than a C in that class, so at last, in desperation, she got out the George Gamow books her brother had given her. In them a mild-mannered bank clerk by the name of Mr. Tompkins was forever going to lectures on science, falling asleep within minutes, and having educational dreams about, for example, the "tribe of gay electrons." Evelyn put one of Mr. Tompkins's surreal lessons into her own words, turned the account in to her comp teacher, and received an A-plus for her trouble. And that was that: she spent the rest of the term writing on subjects like quantum mechanics. As far as she could see, it was the only way she could get a decent grade.

Near the end of the year, Evelyn prepared to transfer out of Queens College to someplace well beyond New York City, ideally Antioch in Ohio or Reed in Oregon. That had been the plan all along: she had agreed with her parents that she would go to the local school, live at home, and take advantage of the free tuition and a $350 scholarship for one year, after which she would leave. But she found that as a transfer student she was ineligible for most financial aid, and because of the Fox family's economic status, that meant she was stuck.

"This was a big blow," she recalls. "I felt I had shot myself in the foot. It was infuriating." Her parents, who preferred that she remain in their nest, were pleased with the turn of events, which made matters even worse. "I was hellbent on leaving by then and the farther away the better. I decided I would go to Antioch or Reed anyway and just somehow work my way through," she says. It was a classic parent-child standoff, with only the slimmest prospects for a peaceful resolution—until her brother intervened.

How about Brandeis? he suggested, deploying the formidable diplomatic skills that years earlier had worked the miracle of bringing Evelyn to an orthodontist's office in the Bronx. Brandeis, in fact, was the perfect solution. It was much closer to New York than Antioch or Reed, it would give Evelyn a little scholarship money, and it was a Jewish school, which made her par-

Keller discovered physics by reading the popular science writer George Gamow, whose work suggested essay topics for a class in freshman composition.



TOY UNIVERSE

The professor raised his eyes from his note-book. "There are no mornings here," he said, "there is no sun and not a single luminous star in this universe. It is lucky that the bodies here show some chemical process on their surface, otherwise I should not be able to observe the expansion of this space", and he returned again to his note-book.

There are no mornings here

Mr Tompkins felt quite unhappy; to meet the only living person in the whole universe, and to find him so unsociable! Unexpectedly, one of the little meteorites came to his help; with a crashing sound the stone hit the book in the hands of the professor and threw it, travelling fast through space, away from their little planet. "Now you will never see it again", said Mr Tompkins as the book got smaller and smaller, flying through space.

4

TOY UNIVERSE

"On the contrary", replied the professor. "You see, the space in which we now are is not infinite in its extension. Oh yes, yes, I know that you have been taught in school that space is infinite, and that two parallel lines never meet. This, however, is not true either for the space in which the rest of humanity lives, or for the space in which we are now. The first one is of course very large indeed; the scientists estimated its present dimensions to be about 10,000,000,000,000,000,000,000,000 miles, which, for an ordinary mind, is fairly infinite. If I had lost my book there, it would take an incredibly long time to come back. Here, however, the situation is rather different. Just before the note-book was torn out of my hands, I had figured out that this space is only about five miles in diameter, though it is rapidly expanding. I expect the book back in not more than half an hour."

"But", ventured Mr Tompkins, "do you mean that your book is going to behave like the boomerang of an Australian native, and, by moving along a curved trajectory, fall down at your feet?"

"Nothing of the sort", answered the professor. "If you want to understand what really happens, think about an ancient Greek who did not know that the earth was a sphere. Suppose he has given somebody instructions to go always straight northwards. Imagine his astonishment when his runner finally returns to him from the south. Our ancient Greek did not have a notion about travelling round the world (round the earth, I mean in this case), and he would be sure that his runner had lost his way and had taken a curved route which brought him back. In reality his way was going all the time along the straightest line one can draw on the surface of the earth, but he travelled round the world and thus came back from the opposite direction. The same thing is going to happen to my book, unless it is hit on its way by some other stone and thus deflected from its track. Here, take these binoculars, and see if ..."

Mr Tompkins put the bino... which somewh...

THE QUANTUM ROOM

observed analogous phenomena before, but to-day he had not taken a single drop of whisky and he could not understand why it was happening now. "Well," he thought, "let us see how this gruel of a ball is going to hit another one."

The player who hit the ball was evidently an expert and the rolling ball hit another one head-on just as it was meant to. There was a loud sound of impact and both the resting and the incident balls (Mr Tompkins could not positively say which was which) rushed "in all different directions". Yes, it was very strange; there were no longer two balls looking only somewhat gruelly, but instead it seemed that innumerable balls, all of them very vague and gruelly, were rushing about within an angle of 180° round the

14

THE QUANTUM ROOM

direction of the original impact. It resembled rather a peculiar wave spreading from the point of collision.

Mr Tompkins noticed, however, that there was a maximum flow of balls in the direction of the original impact.

"Scattering of S-wave", said a familiar voice behind him and Mr Tompkins recognized the professor. "Now", exclaimed Mr Tompkins, "is there something curved again here? The table seems to me perfectly flat."

"That is quite correct", answered the professor; "space here is quite flat and what you observe is actually a quantum-mechanical phenomenon."

"Oh, the matrix!" ventured Mr Tompkins sarcastically.

"Or, rather, the uncertainty of motion", said the professor. "The owner of the billiard room has collected here several objects which suffer, if I may so express myself, from 'quantum-elephantism'. Actually all bodies in nature are subject to quantum laws, but the so-called quantum constant which governs these phenomena is very, very small; in fact, its numerical value has twenty-seven zeros after the decimal point. For these balls here, however, this constant is much larger—about unity—and you may easily see with your own eyes phenomena which science succeeded in discovering only by using very sensitive and sophisticated methods of observation." Here the professor became thoughtful for a moment.

"I do not mean to criticize," he continued, "but I *would* like to know where the man got these balls from. Strictly speaking, they could not exist in our world, as, for all bodies in our world, the quantum constant has the same small value."

15

ents much less nervous. Besides, the physicist Leo Szilard, a friend of Maury, had strong connections to Brandeis, "so everything was sort of all in the family," Keller points out.

Maury was also hoping that Szilard would pick up where Gamow's Mr. Tompkins had left off, further impressing Evelyn with the joys of science—"he sicced Leo Szilard on me" is how she puts it now. However, the young woman, happily sprung from her parents' apartment, continued to have her own ideas about how to run her life. Once at Brandeis, she did major in physics, but that was only because she happened to be good at it, and because she felt like thumbing her nose at people who thought such talent was impossible in girls. Her actual interest in the subject, she figured, was just strong enough to get her through college and into medical school, where her psychoanalytic training would begin.

Then came her senior year, when she worked independently with physics professor Sam Schweber, writing a thesis on the work of physicist Richard Feynman.

Writing her biography of maverick geneticist Barbara McClintock gave Keller insights into gender and science that she would have been hard-pressed to find otherwise

"She was clearly very, very bright," Schweber remembers. "She simply devoured the math. She had no difficulty at all with the technical material, which is unusual." Even more unusual, Evelyn was doing more than just showing off. She had become a devotee, a convert to the idea of making sense of the world through pure, precise thought. "I fell in love with theoretical physics," she says, and on the strength of that love she applied for a National Science Foundation fellowship, which she won. In the fall of 1957, she would enroll in graduate school at Harvard. "In my adviser's fantasies, I was to rise, unhampered, right to the top," she relates in a memoir called "The Anomaly of a Woman in Physics" that she wrote 17 years later. "In my private fantasies, I was to be heralded all the way." Unfortunately, quite a different experience was in store.

Woman versus Scientist

Evelyn did manage to rack up a string of A's—not that it mattered. Her seriousness and ambition were publicly derided by both her peers and her elders. If the work she turned in was especially good, her professors suspected her of having plagiarized it. On one such occasion, when she learned that a paper of hers had provoked a good deal of intellectual debate in the department, she went to see the professor for whom she had written it: they had an interesting discussion, after which he kindly inquired from what articles she had copied her argument.

Didn't she know that no woman at Harvard had ever succeeded in becoming a theoretical physicist? people occasionally asked her with amusement. And whenever it occurred to them that she might be the one woman who could break the tradition, they simply found the idea titillating. "I was leered at by some, invited now and then to a faculty party by others," she recounts in her memoir. "The open and unbelievably rude laughter with which I was often received at such events was only one of the many indications that I was on display—for purposes I could either not perceive or not believe."

She was making a name for herself indeed, but the process was a nightmare. She was completely isolated. "My real world began to resemble a paranoid delusion. Many people in Cambridge knew who I was and speculated about me. None of them offered friendship." After two years of such treatment, Evelyn, who had always delighted in her intelligence and trusted others to do the same, was a wreck—defensive, weepy, and unapproachable. She passed her orals but decided not to do a thesis. She was going to get out of physics; she was going to enter a more hospitable profession; she was going to become a psychoanalyst after all. When Maury invited her to spend the summer with him and his young family at Cold Spring Harbor, home of the Long Island Biological Laboratories, she went with a suitcase full of Freud. Her knowledge of psychoanalysis was limited to her sister's tantalizing description of the unconscious more than a decade ago—between one thing and another, she had never got around to taking a single psychology course—but she would take care of that problem in short order and then pursue her new, true vocation.

It was not to be. Cold Spring Harbor was crawling with brilliant biologists, and since her brother was one of them, their world was temptingly accessible. Moreover, their attitude toward her, she soon realized, was a lot more accepting than that of most members of the Harvard Physics Department. After a few weeks of doing lab work in such good company, she stumbled upon a technique that suggested an experiment she could conduct as the centerpiece of a physics thesis—an experiment in molecular biology. The idea was not so strange as it might seem today: throughout the late fifties and early sixties, physicists were going into molecular biology "in droves," as Keller puts it. The powerful, stripped-down models of biological processes that were at the heart of the new discipline were especially attractive to them. In fact, when Evelyn returned to Harvard, she was able to find a member of the Physics Department who was making the transition to molecular biology himself and was willing to serve as an official adviser for the thesis she was working on with Mesel-

son. It was Walter Gilbert, who in 1980 would win a Nobel Prize for developing methods to map DNA.

In 1963, having completed her PhD, she returned to New York and taught physics in night school at New York University while doing research part-time for the mathematician Joseph Bishop Keller. A year later she married him, and they had two children in rapid succession—Jeffrey, now 27 and a graduate student in computer science at the University of California at Santa Cruz, and Sarah, now 26 and a reporter for the *Simi Valley Enterprise* in suburban Los Angeles. She also began the work in mathematical biology that would make her name as a scientist.

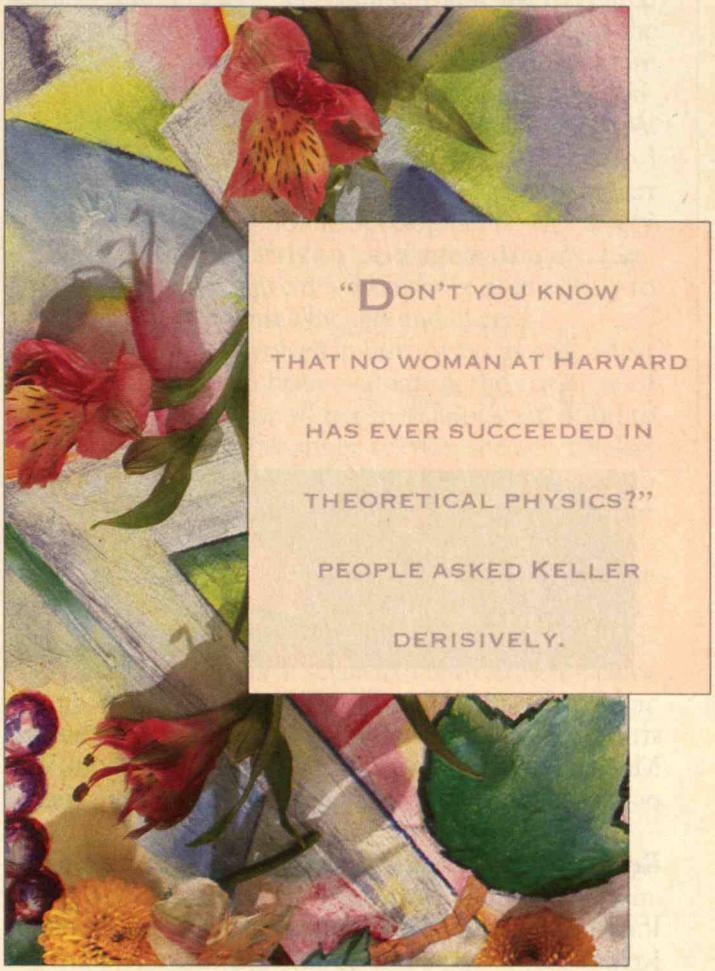
But while she was now in much better shape than she had been at Harvard, she was still wrestling with a conflict between her identity as a scientist and her sense of herself as a woman. And it was through this fundamental conflict that she did, finally, some 20-odd years after her interest had been piqued, learn a thing or two about psychoanalysis. Only instead of being the doctor as she had always imagined, she was the patient.

In therapy, she, like any other patient, learned to examine her unwitting words and actions for clues to the submerged thought patterns that were helping to determine the course of her life. For someone whose sole intellectual frame of reference came from traditional science, it was a whole new way of looking at the world. Suddenly, subjective experience was worth taking seriously, and beliefs, whether conscious or unconscious, well-founded or totally erroneous, were seen to have palpable effects. The women's movement, which she encountered in the late sixties and early seventies, further emphasized the role of subjective experience—the idea that "the personal is the political" is perhaps nowhere more central than in feminism.

Thus, in fits and starts, Keller's concerns became more philosophical, and although she continued to love science, she gradually ceased to practice it. In 1974, at the State University of New York at Purchase, she taught her first women's studies course. When she was invited to give a series of talks on the mathematical aspects of biology at the University of Maryland that same year, she concluded them with the bold gesture of discussing the relative absence of women in science. And a few months later she exorcized the pain of her graduate school experience in "The Anomaly of a Woman in Physics," which in 1977 was published in *Working It Out*, a collection of pieces on women and their work. One of the people who read it called her up and said, "You know, someone should write something about Barbara McClintock."

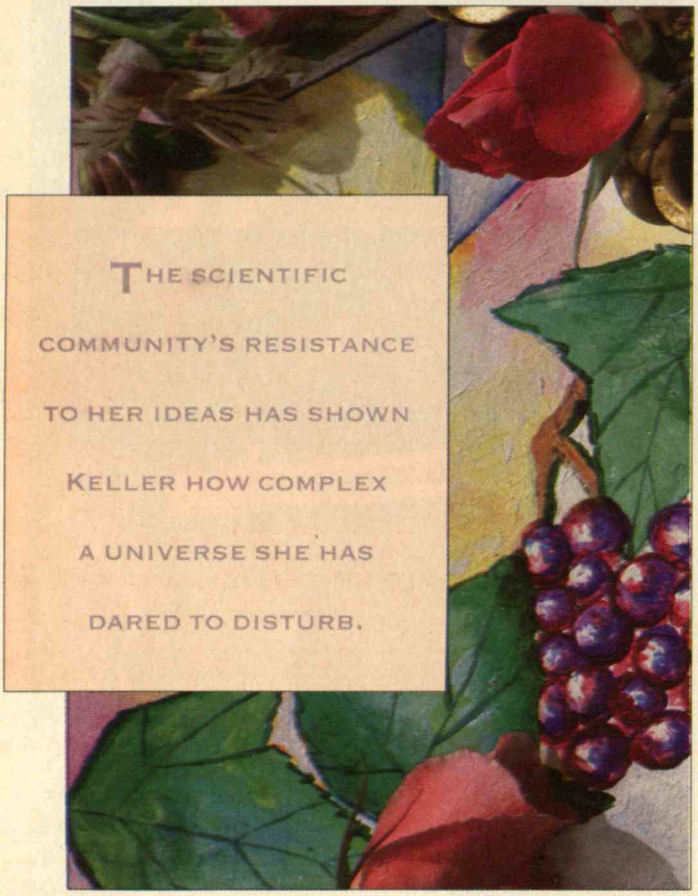
She thought it was a great idea for a short article, and so she contacted McClintock through a mutual friend, who sent along a copy of "The Anomaly of a Woman in Physics." McClintock, who liked the piece, agreed to talk to her. However, Keller got more than she had bargained for. "I realized from the first conversation that this was an amazing story and it needed more than a small article," she says. "I was obliged to put everything aside and become the vehicle for Barbara McClintock."

In a way, it was a logical next step for Keller: she had recently completed a memoir about having been treated like a freak for a few years, and she was moving on to write the biography of a woman who had been treated like a freak by the vast majority of her colleagues for decades. In the 1950s, when McClintock's discovery about jumping genes was starting to earn her outsider status in the scientific community, one prominent geneticist who visited her lab at Cold Spring Harbor told her, "Now I don't want to hear a thing about what you're doing. It may be interesting, but I understand it's kind of mad." Another, speaking behind her back, got big laughs for the line that she was "just an old bag who'd been hanging around Cold Spring Harbor for years."



Keller had caught a glimpse of McClintock's isolation herself that long-ago summer at Cold Spring Harbor with Maury. Still raw from Harvard, she had found something terrifying in the sight of the aging, eccentric geneticist on her solitary walks. "Barbara McClintock represented everything I was most afraid of—that becoming a scientist would mean I'd be alone," she remembers.

And Keller was hardly the only one who had an uncomfortable reaction to that isolation: in the end, McClintock, having told her tale, couldn't face actually reading it. When Keller first started drafting parts of *A Feeling for the Organism*, she sent them to McClintock, who would respond. But after a while, the responses



stopped. The material was too upsetting. Although McClintock was to live for nine years after the book was published, she would always claim never to have read it.

Reflections and Its Aftermath

If narrating the McClintock story grew naturally out of Keller's past emotional experience, it also advanced her future intellectual endeavors. In her protocol-violating lecture at the University of Maryland in 1974, she had raised a question that, as the years passed, began to seem more pressing. By the time she was talking to McClintock, Keller realized that it was the start of a major piece of work—it was, in fact, the question about people's conceptions of science and masculinity that would eventually lead to *Reflections on Gender and Science*.

The McClintock biography appeared at first to have nothing to do with that project, and Keller was dismayed to find how much energy was required to work with this complicated, iconoclastic scientific genius whose story demanded to be told. To make matters worse, Keller and her husband had just divorced, so that in addition to carrying a sizable teaching load at SUNY, she was raising two children virtually by herself. But while McClintock of course relieved neither the teaching nor the child-care responsibilities, her unconventional ideas, her unconventional approach to her subject matter, indeed her whole unconventional self suggested insights into the issue of gender and science that would have been hard to come by any other way. Not surprisingly, Keller wound up quoting liberally from *A Feeling for the Organism* in *Reflections*. Certainly her vision of what science could be would have been less convincing without the description of what, for McClintock, it already was.

Interestingly, too, for all Keller's experience in science, she did not consciously understand that people would object to *Reflections* until December of 1984, when she received her first advance copies of the book. Two weeks before Christmas she woke up in the middle of the night drenched with sweat. "Oh my God, they're going to destroy me. They're going to tear me limb from limb," she thought. Once she calmed down, she became aware that she had been instinctively playing her cards somewhat close to her vest for the 10 years it had taken her to finish the book.

"I realized, for starters, that my family didn't have a clue as to what I'd been writing. Now, we're very close, but for some reason I just didn't tell them. So I gave them each an advance copy of *Reflections* and I said, 'Look, I want you to have this. But you don't have to like it. You don't even have to read it,'" she recalls. And as far as she knows, they took her up on that suggestion—even Maury, who 40 years back was encouraging her to go into science and who, as a biologist, might be assumed to have a professional interest in her ideas. That's fine with her, though. She explains, "My family loves me for what I am, not for what I write."

Needless to say, the love of people outside that small circle is somewhat more conditional, and Keller has found that just as she had feared, many observers, especially those who are practicing scientists, have indeed tried to discredit her—even though they appear not to have read her work either. "She and her friends—I try not to remember the names of these people—have stirred up a tremendous tempest in a teapot," one Nobel Prize-winning physicist told me. "I make a point of not paying any attention to it." He went on to complain about how she has "denied the validity of Western science." Another detractor, this one a top-ranking biologist, reported that she and all the other women scientists of her acquaintance "were in shock when Keller came out with those ridiculous ideas. The notion that women scientists are more intuitive—well, it's nonsense. It's nothing but a stereotype."

Anyone who has read even the introduction to *Reflections* knows that those charges are groundless. Yet they

persist. Moreover, even the practicing scientists who voice what might seem to be useful criticism of Keller's ideas tend, in her view, not to be responding to what they actually are. For example, MIT biologist Robert Weinberg faults her for not recognizing that the driving force behind science is to generate good, solid findings. Whatever else you want to say about the traditional modus operandi, you have to admit that it has been productive, he argues—put bluntly, it works. But Keller points out that Weinberg is "just articulating the dominant ideology of science."

The reactions of her admirers frequently disturb her as well. For every irate physicist or biologist who accuses her of saying that science is a crock or that women are repositories of intuitive, heal-the-earth-type wisdom, there seems to be a humanities major who applauds her for the same reason. Nancy Cartwright, chair of the Philosophy Department at the London School of Economics, notes that many of Keller's so-called advocates "just want to discredit science so they can go on and study literature or something."

Still, many scholars, historians of science in particular, have read her work carefully and attest to its influence. University of Toronto philosopher and historian of science Ian Hacking points to the importance of her insight that interactions between scientists and their subject matter deserve more consideration—her concept of dynamic objectivity and her thoughts about Barbara McClintock's unorthodox methodology have clearly not been lost on him. York University historian of science David Noble calls Keller a pioneer and notes that she's one of the few academics working outside of science who truly understand the discipline and care about it.

Stephen Jay Gould, who teaches biology, geology, and history of science at Harvard, praises her tough-minded—and successful—attempt to "avoid myths and capture subtleties." Carol Cohn, Lang Visiting Professor of Social Change at Swarthmore, reports that her own writing on the thinking styles of defense experts is indebted to Keller's critique of scientific objectivity. Ruth Perry, head of the Women's Studies Department at MIT, says that "it's no longer possible to write about the history of science without considering gender, and it's not possible to write about gender and science without citing Keller."

Keller has also had a substantial impact in college classrooms, both as a teacher and as an author of assigned texts. Eleanor Duckworth, professor of education at Harvard, notes that she writes about the history of science in a way students can truly understand, the complexity of some parts of *Reflections* notwithstanding. Perry remembers that when Keller was a visiting scholar at MIT in the early to mid-1980s, her classes were so lively they attracted people from all over town, including faculty and graduate students.

One of those who sat in on Keller's classes during that period, MIT biologist Sallie Chisholm, proves that even if many practicing scientists resist the ideas in *Reflections*, a few others, though not exactly pushovers themselves, are ready to listen. "I was skeptical at first, but as the classes went on, I decided that Keller was on to something," Chisholm says. "She took my brain and twisted it a few degrees, and the result is that now I can step back and look at the context of my research."

Hardly the dramatic reaction Keller had set her sights on in 1985, but nothing to sneeze at, either, as she now knows. The adamant resistance so many members of the scientific community have exhibited toward *Reflections* may have been disappointing, but at least it has shown her how complex an intellectual universe she has dared to disturb, and how naive she was to imagine that she could change it so easily. She says, "I have a much more sophisticated reading today of how science grows. Basically it grows in response to the opportunities available and the opportunities are created in part by technical developments, in part by cognitive developments, in part by social-political-economic developments—it's a very elaborate system and it's got a lot of internal momentum. People like me who give it a little shove aren't likely to affect it a great deal. Just a bit here and there."

Her thinking has evolved in other ways as well. Most significantly, she has been evaluating the criticism of those who say that for all her meticulous attention to how ideas about gender shape science, she nevertheless takes scientists' claims for their accomplishments too much at face value. Those remarks have compelled her to seriously examine the whole issue of how astoundingly productive traditional science has been. And she wishes others would do the same. In her new book she implores a current generation of historians, philosophers, and sociologists of science to redress their lack of attention to "the undeniable record of . . . success that science as we know it can boast."

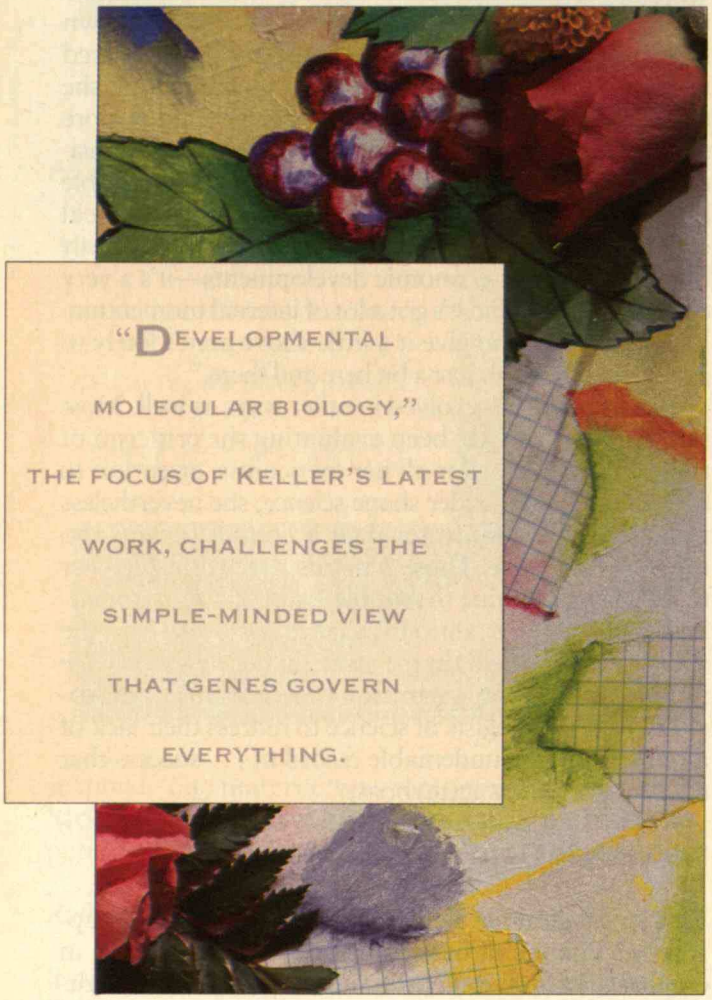
Subverting Its Own Paradigm

This recent strain in Keller's thinking doesn't quite represent a change of heart—it's more like a change in emphasis. In both *Reflections* and her more recent writing she maintains that the course of science is determined not only by what works in the lab but by what beliefs and goals shape the lab workers' point of view. The difference is that today she focuses more on what works in the lab. She also takes a more critical view of what it means for something to "work."

She grounds many of her new perspectives in an examination of scientific language: it's there, she argues, that the beliefs that shape lab workers' outlook can be most clearly seen to affect what works in the lab. "Sharing a language means sharing a conceptual universe," she remarks in *Secrets of Life, Secrets of Death*, and she adds that in scrutinizing the words scientists use, critics

can "expose the many forks in the road to knowledge that . . . conventions . . . have worked to obscure."

Consider "competition." When biologists address themselves to questions about evolution, they routinely invoke that term, which, technically, refers to how organisms deal with limited resources. The problem is that the word connotes aggression—indeed, struggles to the death—and what biologists observe in their petri dishes conforms to this notion just enough to obscure questions about the other strategies organisms use to accommodate scarcity.



"DEVELOPMENTAL MOLECULAR BIOLOGY," THE FOCUS OF KELLER'S LATEST WORK, CHALLENGES THE SIMPLE-MINDED VIEW THAT GENES GOVERN EVERYTHING.

That wouldn't be so terrible if those other ways weren't effective, but in fact they are. For instance, organisms can ensure their survival by reproducing less prolifically. Or they can use resources more efficiently. Such mechanisms are usually assigned special-case status and forgotten. Whatever researchers might have learned from studying them remains unlearned, and the gap in our understanding of nature is not recognized at all, even though science continues to generate new knowledge, often reams of it, in the very same area.

Yet Keller isn't calling for more "neutral" language—she notes that language, including scientific language, is the product of human beings and as such cannot help but reflect their values. What she would like to see is greater awareness among scientists that this is so, and greater receptivity to different ways of describing scientific phenomena. Otherwise the discipline's success stories may blind scientists to much of what happens in the natural world. If *Reflections* makes the point that people cannot escape their subjectivity, *Secrets of Life, Secrets of Death*, in its preoccupation with scientific language, makes that point even more strongly.

But does this mean she thinks that none of the gaps in scientific knowledge will ever be addressed if scientists fail to heed her advice? She says no, and explains why in her very latest work, now in draft form. As is usually the case with Keller's endeavors, the genesis was roundabout. A while back she was criticizing the Human Genome Project, whose goal is to map all the genes in the human body. The whole idea, she argued, is based on the simple-minded view that genes govern everything—a view whose limitations come into sharp focus once you start asking a few rather obvious questions.

For example, if genes govern everything, and if all cells have the same genes, then how do embryos develop? How do cells differentiate—why does one become part of the brain, another part of the liver, another part of the elbow? Some advocates of the project replied that her argument was obsolete. We are beginning to find out how genes control the development of embryos, they pointed out.

"I said, 'Oh yeah? Really?' I thought I better find out what they were talking about and what I discovered was so interesting that it completely shifted the course of my research," she reports. It turns out that over the past couple of decades a new field has been forming. Called "developmental molecular biology," it neither brushes aside that awkward question about differentiation nor fudges it with lame theories. Instead, researchers seek to understand how genes respond to signals coming from both inside and outside a cell's nucleus: these researchers have reason to believe that the cytoplasm, long conceived merely as a supporting nutrient environment for the nucleus and its all-important genes, is actually a control center in its own right and dictates much of what happens in differentiation.

"It's really exciting. Molecular biology is subverting its own paradigm," she says. And the history behind the phenomenon goes back almost a hundred years: developmental molecular biology represents a revival of concerns that preoccupied scientists in the late nineteenth and early twentieth centuries before they were dropped in the flurry over genes. Clearly, this topic has Evelyn Fox Keller written all over it—there's a major change brewing in scientific thought, and a historical background promises to go a long way toward explaining that change. No doubt she's going to be busy for a long time to come. ■

Escape from Engineering Boot Camp

INERTIA, as every engineer learns in school, is the tendency of things to remain at rest or continue moving in a fixed direction unless acted upon by some outside force. In short, the term means resistance to change. For decades there has been no better example of inertia than engineering education itself.

Just about everyone agrees that we have to improve the way we teach our engineers. Yet in discussions with engineering faculty, deans, and students, as well as with employers of engineers, I find not only apathetic acceptance of the status quo but also widespread cynicism about the many studies and programs that purport to improve the system.

In today's typical undergraduate curriculum, students spend their first two years studying mathematics, physics, and chemistry and their final two years concentrating on a variety of engineering sciences. Over the four-year period they take only a smattering of liberal arts—usually no more than the six or so courses required for accreditation. The regimen has always had its critics, but as U.S. technology progressed from one triumph to another, and as American industrial prowess became the marvel of the world, who could quarrel with success?

But we live now in a different world, and U.S. industry is having trouble competing in world markets. Our technological edge seems to have dulled. As the country's economic problems worsen, the perceived faults of engineering education are announced with growing urgency: Our graduates don't understand manufacturing processes; they lack aptitude for design, having concentrated too much on abstract theory; and they are poor communicators, have little understanding of business and politics, and are uninformed about other cultures and world affairs.

Equally ominous, at the very moment that more engineers are needed at every level of society, the profession seems to be losing its attraction to young people. Since the peak year of 1986, the annual production of undergraduate engineering degrees has declined more than 18 percent. Fully one-third of freshmen engineering majors abandon the program by their senior year. For women and minorities, already terribly underrepresented at the entry level, attrition is considerably higher. Studies indicate that only a small part of this loss is attributable to academic failure. Students are dropping out of engineering school for the same reason they are shunning it in the first place: the program is laborious and disagreeable.

Once this major problem has been identified, the solution seems stunningly obvious. We should stop looking at engineering school as a sort of boot camp designed to filter out all but the most dogged survivors. We should bring practical, creative, "fun" engineering into every year, particularly the first, and teach mathematics and the sciences as enabling complements to engineering rather than isolated afflictions to be endured. We should advise and nurture students at every step along the way. That way we will attract talented young people to engineering, keep them from dropping out, and at the same time improve the quality of our graduates.

It all seems so simple, particularly the nurturing part. But more than a century of Spartan tradition stands in the way. Older engineers tend to feel that if they survived the ordeal, others can too. Many Asians who have entered the ranks of junior faculty come from cultures that stress hard work with no frills. As a dean said to me recently, "It is easy to say, 'Change the culture!' but so very hard to accomplish." Inertia.

Yet the mood of urgency is palpable, and important transformations may be about to occur. As a member of the National Research Council's Board on Engineering Education, established in 1991, I have had the opportunity to observe presentations by many impressive people committed to constructive change. The National Science Foundation is supporting a variety of initiatives such as awarding grants not only for good research but for good teaching, and NSF is funding coalitions of engineering schools to work together on innovative efforts. Numerous schools are, on their own, exploring fresh approaches to curriculum. A new program at Carnegie-Mellon, for example, has freshmen designing subsystems for a simple robot—surely a far more stimulating activity than solving differential equations.

A few months ago I heard Jeanne Kirkpatrick, historian and diplomat, speak on the revolutionary changes that have occurred in the former Soviet Union. She admitted that she and other "experts" had been taken by surprise. They had failed to consider what can happen when a new generation comes to maturity and sizes up the problems that confront it. In engineering education today, a new generation is upon the scene. I sense the marshaling of the "outside forces" needed to overcome inertia. ■

PHOTO: L. BARRY HETHERINGTON

SAMUEL C. FLORMAN, a civil engineer, is the author of Engineering and the Liberal Arts, The Existential Pleasures of Engineering, Blaming Technology, *and* The Civilized Engineer.

Ask the engineer an American car

1993 Chrysler Town & Country

Ask David and Lisa Tarnosky, from Houston, Texas. They hadn't owned an American vehicle since 1979.

But that was before their kids tried out a 1992 Chrysler Town & Country minivan.

"Marissa and Natalie jumped in and started playing right there in the showroom. We figured they wouldn't let us go home without it.

"With all the features we were able to order, it seemed crazy not to buy a Town & Country. The

who hadn't owned in over ten years.

airbag.† The anti-lock brakes. The separate air conditioning for the back seats.

"And the kids love our Captain's Chairs in back. It's like a playhouse back there.

"We love the quality. My friends can't believe how quiet it is. We made the right choice."

Talk to David Tarnosky and you'll know. The best advertising really is word-of-mouth.

Call 1-800-876-MINIVAN to tell us your story. Maybe we'll use it, too.

The Minivan Company.™

CHRYSLER
Plymouth

Winning Through Collaboration

ON the same day last July came two announcements that raised far-reaching questions about the proper role of the U.S. government in overseeing the country's technological activity. Silicon Valley chipmaker Advanced Micro Devices and Japan's electronics giant Fujitsu declared that they would jointly develop "flash" memories—devices that retain stored information when the power is shut off and that could someday replace hard disks. Almost simultaneously, IBM disclosed that it was joining forces with Toshiba and Siemens to develop another generation of memory chips. Both announcements focused attention on a key policy question: Why should the U.S. government support research consortia when so many of the member companies are teaming up with foreign firms?

In fact, these foreign alliances are perfectly compatible with the need for a national industrial/technology policy. Even a multinational corporation needs a strong "home base" from which to secure domestic markets, develop relations with suppliers, and learn new production technologies. And shoring up this home base—by building infrastructure, training workers, providing technical assistance, and encouraging collaboration among rivals—is what industrial policy is all about. Taking such actions makes U.S. companies more attractive as suppliers to foreign firms, as well as their customers and technology partners.

Critics say it is unfair to let foreign partners have access to technology whose development was subsidized by U.S. taxpayers. But why assume that an American member of a government-sponsored consortium will necessarily transfer knowledge gained from domestic collaborations to its foreign allies? Big companies—particularly defense contractors—are well-practiced at compartmentalizing proprietary information.

Besides, whatever leaks may in fact occur from a domestic consortium into a cross-border alliance would not necessarily compromise a national industrial policy. Much research on innovative products or production processes has become too costly and risky for an individual company to tackle on its own; as a result, arguably, the rate of market-driven technological progress has slowed. Most cooperative enterprises—including Sematech, the semiconductor R&D collaborative in Austin—focus on generic, "pre-competitive" R&D and therefore socialize part of those costs and risks. As long as the principal beneficiaries of the public investment in any nation's (or region's) technology consortia are domestic companies and resident workers (whatever the color of their passports), why worry about the indirect involvement of foreign-based technology companies such as Fujitsu or Siemens? True, Fujitsu's access to a consortium might allow it to develop some new computer technology sooner than, say, IBM, and therefore to gain a short-term edge. But if strategic alliances proliferate, such a lead won't last long.

Such openness is not novel. The European Community's publicly supported consortia, such as Esprit and Jessi, already permit U.S. companies to participate in their activities. In return, the EC expects the American companies to involve themselves in research, development, or production within Europe.

The United States could do the same. Why not, for example, extend privileges of membership to the overseas partners of Sematech's U.S. members—so long as those partners conduct some of their project-related work here? At a minimum, we could make foreign participation in U.S. laboratories such as the superconducting supercollider contingent on payments to the American consortium by the foreign governments. Better still, countries could negotiate reciprocal memberships in each others' consortia.

Unfortunately, such moderate suggestions tend to get drowned out by two opposing dogmas that dominate debate on this issue. One camp holds that any technology invented in the United States should be prevented from leaking out of the country—especially if U.S. taxpayers subsidized the research. In contrast to this nationalistic viewpoint is the notion that cross-border technology alliances show that multinational corporations no longer have any real home base. National policies to make individual companies or industry sectors more competitive, according to this argument, are not just ineffective but meaningless.

Both of these views are wrong. Companies do have homes bases and national loyalties. But they are also becoming more likely to set up shop in one another's back yards. Instead of ignoring these changes, or imagining that a country's technology policy can or should be confined to its own citizens, Congress and the president should work with our allies to develop new rules and arrangements by which nations, as well as corporations, might form alliances to promote global technological progress. ■

BENNETT HARRISON is professor of political economy in the H. John Heinz III School of Public Policy and Management at Carnegie Mellon University. His most recent book is The Great U-Turn: Corporate Restructuring and the Polarizing of America *(Basic Books).*

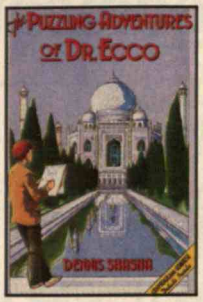
PHOTO: L. BARRY HETHERINGTON

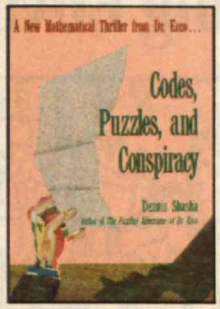
Thoughtful gifts for thinking people

THE PUZZLING ADVENTURES OF DR. ECCO
by Dennis Shasha

An intriguing book of puzzles and problems presented as the fictional tale of Dr. Jacob Ecco, legendary mathematical detective. Try to solve nearly 40 puzzles found in math and computer science — some of which have stumped physicists and computer scientists. You don't need background in either subject, "only a clear head and imagination." Solutions in back of book.

Paperback, 183 pages, $11.95.





CODES, PUZZLES, AND CONSPIRACY
by Dennis Shasha

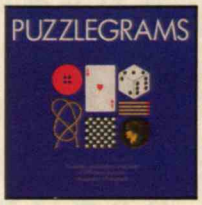
The second in the bestselling series of mathematical thrillers featuring the brilliant and eccentric Dr. Jacob Ecco. In this fast-paced book, readers are invited to solve a series of fascinating puzzles, and compete for the grand prize—a pair of roundtrip tickets to London.

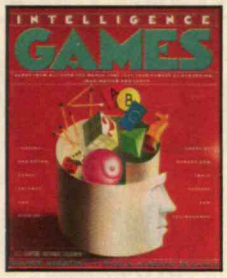
Paperback, 242 pages, $11.95.

PUZZLEGRAMS
by Pentagram

A collection of 178 classic puzzles recreated by one of the world's leading design firms. The book is a stunning, 4-color combination of design and conundrum.

Paperback, 187 pages, $15.95





INTELLIGENCE GAMES
by Franco Agostini & Nicola Alberto Decarlo

A collection of riddles, logic, boardgames, and enigmas from all over the world to "test your powers of reasoning and savvy."

Paperback, 184 pages, $15.95

PANATI'S EXTRAORDINARY ORIGINS OF EVERYDAY THINGS
by Charles Panati

This book unveils the roots, meaning and superstitions behind the objects and vocabulary of our daily lives. A must for anyone fascinated by curious facts, trifles and trivia.

Paperback, 463 pages, $13.00.

WORKING PAPER CLOCK
by James Smith Rudolph

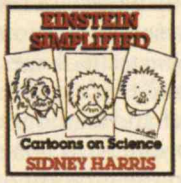
Make your own working clock, entirely from paper. Cut this book into 160 pieces, add a few odds and ends and glue them together, and you'll have a piece that keeps perfect time.

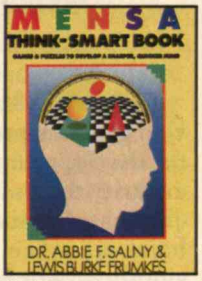
Paperback, $12.00.

EINSTEIN SIMPLIFIED
Cartoons on Science
by Sydney Harris

No area of science escapes the sharp wit and wayward pen of cartoonist Sidney Harris. A delightful collection of more than 150 cartoons to tickle your funny bone.

Paperback, 160 pages, $9.95





MENSA THINK-SMART BOOK
by Dr. Abbie F. Salny & Lewis Burke Frumkes

A book of games and puzzles to develop a quicker mind. Give yourself or a friend a Mensa workout with math, logic, memory problems, and more.

Paperback, 124 pages, $7.95.

Ordered by:

Name _____

Address _____

City _____ State _____ Zip _____

Ship to:

Name _____

Address _____

City _____ State _____ Zip _____

Prepayment, in U.S. funds only, is required

Check or money order enclosed for $ _____ Charge my: _____Mastercard _____Visa

Card # _____ Expires _____

Signature _____

Send order with payment to:
Technology Review Books, MIT-W59, Cambridge, MA 02139
To order by phone with Visa or Mastercard, call (617) 253-8292, 9-5, EST, Mon.-Fri.

Qty	Title	Price	Total

# of Items	U.S.	Outside U.S. Surface Mail
1	$2.00	$3.25
2	$2.75	$5.00
3 - 4	$3.50	$6.75
5+	$4.25	$8.50

For 3 or 4 items subtract $1.00

For 5 or more items subtract $2.00

Add shipping (see chart)

Grand Total

DAVID E. BLOCKSTEIN

Orchestrating Environmental Research

As the complexity of the world's environmental problems becomes clear, the need for interdisciplinary—problem-oriented—research becomes more critical. Yet in the United States, funding for environmental R&D remains at modest levels. Only $500 million of the U.S. Environmental Protection Agency's $6.5 billion budget is devoted to research.

Of course, EPA is not the only federal entity funding such endeavors, but therein lies an even greater problem: the paltry amounts are spread over a wide range of agencies, each with its own mission and problems. And there is little coordination among these agencies or their environmental programs. Such splintering prevents the broad analysis, understanding, and certainly the resolution of most environmental problems, which transcend disciplines and cut across agency boundaries.

For example, the thinning of the earth's ozone layer will allow high levels of ultraviolet radiation to pass through the earth's atmosphere during much of the next century. This radiation is likely to affect public health (making it the business of the Department of Health and Human Services), crops (Department of Agriculture), habitats such as wetlands (Department of the Interior), and marine life (the National Oceanic and Atmospheric Administration in the Department of Commerce). Yet aside from a small program in EPA, the United States maintains no research effort to evaluate the ecological effects of UV radiation.

The underinvestment in research affects not only science but also technology. Many of the debates at the recent Earth Summit in Rio de Janeiro hinged on whether the developing countries of the South will follow the same environmentally ruinous path to development taken by the North. Yet new technologies that could offer more healthful and productive means to a similar end remain more conceptual than real.

A single federal agency could do for the planet what NIH has done for human health.

One reason is that no agency of the U.S. government is poised to promote the development of these technologies, evaluate their safety and efficacy, and eliminate institutional and economic barriers to their adoption. Such goals simply do not fit into the mission of today's regulatory agencies. We are trying to fight today's problems with yesterday's institutions.

It's time to create a new government research and information structure whose only business is the environment. Just as the United States established the National Institutes of Health for cross-cutting medical research, it should now fund a National Institutes for the Environment (NIE) to deal with our ecological well-being.

Like the NIH, the NIE would be an agency without regulatory responsibilities, and it would operate through external peer review to ensure the highest-quality science. Unlike the NIH, the NIE would include an office charged with summarizing research, translating it for decision makers, and presenting policy options based on the best available information.

The NIE concept is being taken seriously in Washington. With congressional funding, the National Academy of Sciences has convened a Committee on Environmental Research to consider the feasibility of such an institution. The committee is expected to issue its recommendations in early 1993. Meanwhile, Rep. Jim Saxton (R-N.J.) and Sen. Terry Sanford (D-N.C.) have introduced congressional resolutions supporting the NIE, and they expect to draft enabling legislation for it in 1993.

The NIE would be organized around environmental problems rather than disciplines, with research priorities set by a combination of NIE staff and outside panels drawn from government, industry, academia, and citizens' groups. The agency would not maintain its own research laboratories but would instead provide funding for individual researchers and interdisciplinary teams of natural scientists, social scientists, and engineers.

For example, in their efforts to clean up air, water, and soil, today's agencies often wind up transferring noxious wastes from one medium to another. The goal should be development of environmentally benign manufacturing processes and products that operate on a biological model: they would not produce toxic byproducts and useless waste.

Developing such technologies will require a systems approach that considers the entire materials cycle. No existing agency takes such an approach: the NIE would be uniquely positioned to do so. ■

DAVID E. BLOCKSTEIN, an ecologist, is executive director of the Committee for the National Institutes for the Environment in Washington, D.C.

ILLUSTRATION: JAMES KACZMAN

Reviews

BOOKS

THE PRICE OF PREVENTION

Buying Greenhouse Insurance: The Economic Costs of CO_2 Emission Limits
by Alan Manne and Richard Richels
MIT Press, $25

BY ALAN S. MILLER

WITH the signing of a convention on climate change at the June 1992 Earth Summit in Rio de Janeiro, policymakers formally identified a need for better information on the economics, as well as the science, of global warming. The political implications of such information are enormous: if studies show that the risks of delaying action are potentially catastrophic and the costs of reducing emissions modest, then immediate environmental measures are called for; if the risks of delay appear to be modest and the costs of mitigation immense, a more cautious response is in order.

Unfortunately, no hard information is in sight, either way. Estimating the costs and benefits of reducing greenhouse gas emissions is almost as complex as modeling climate change. Economic models tend to be highly sensitive to assumptions about fuel costs, technological innovation, expected growth in global population and income, and other variables.

Alan Manne, a professor of operations research at Stanford University, and Richard Richels of the Electric Power Research Institute are among the most influential analysts at work in this minefield. In November 1989, their research made the front page of the *New York Times* in an article headlined "Curing the Greenhouse Effect Could Run into the Trillions." Because this conclusion meshes with the position of the Bush administration, Manne and Richels have been cited repeatedly in reports by the President's Council of Economic Advisers and other federal bodies.

For those interested in forming their own opinions of Manne and Richels's analysis, the authors have now collected and modestly expanded on their earlier work in *Buying Greenhouse Insurance: The Economic Costs of CO_2 Emission Limits*. They provide a concise and relatively nontechnical discussion of the issues involved in estimating the costs of cutting CO_2. At the same time, they explain the key assumptions and results of Global 2100, their computer-based macroeconomic model of the role of energy in the economy.

Readers will quickly discover that the authors are much less bold about their conclusions than many of those who cite their work. Reflecting their uncertainty about the future, Manne and Richels test a range of assumptions and obtain a wide range of results: in the "pessimistic" scenario—the one seized on by the Bush administration—cutting CO_2 emissions by 20 percent through the year 2100 would cost more than $3 trillion dollars; under "optimistic" assumptions, a 50 percent reduction would cost only a sixth as much.

Nevertheless, the authors' middle ("base") scenario is distinctly gloomy in relation to other prominent models. In another recent book, *The Economics of Global Warming*, William Cline of the Institute for International Economics notes that Manne and Richels built their base case on relatively pessimistic assumptions about energy supply alternatives, improvements in energy efficiency, the extent to which labor and capital can be substituted for energy, and the economy's sensitivity to the availability of energy. This pessimism shows up in the authors' discussion of a popular proposal for taxing carbon consumption. While Manne and Richels argue that cutting U.S. carbon-dioxide emissions by 20 percent could require a long-term tax of $250 per ton of carbon, another oft-cited model developed by Dale Jorgenson and Peter Wilcoxen at Harvard University gives a figure of only $42 per ton.

Buying Greenhouse Insurance offers little help in making sense of such disparities. Of the critical parameters, Manne and Richels defend only their somewhat pessimistic assumption that technological innovation will reduce energy intensity—total energy consumption divided by gross domestic product—by just half a percent per year. They argue that the experience of the last three decades supports their estimates. Yet they fail to establish that such extrapolation is any more sensible over the next 100 years than a nineteenth-century prediction would have been if based on energy trends from 1860 to 1890.

Keeping a Global Perspective

Manne and Richels are less interested in defending specific results than in finding strategies for dealing with the uncertainty inherent in climate change. The greenhouse policy debate, they note, "is enlivened but not necessarily illuminated by rhetoric on 'an irreversible ecological catastrophe' versus the 'staggering costs of reducing emissions.'" The book offers policymakers more realistic choices about how to allocate limited greenhouse dollars.

ILLUSTRATIONS: EVZEN HOLAS

The authors see three alternative areas for investment: continued research to reduce scientific uncertainty, development of new technologies to reduce abatement costs, and immediate emission reductions as a hedge against more drastic cuts that might become necessary in the future. Although Manne and Richels remain infuriatingly neutral on these approaches, they do point out that perfect information could be worth billions of dollars to the U.S. economy in avoiding either excessive CO_2 constraints or excessive emissions.

As the authors recognize, however, counting on improved knowledge assumes that scientific understanding is to some extent predictable. Recent history gives little basis for such an assumption. Some of the most important aspects of ozone depletion were not predicted—much less understood—until irreversible damage had already occurred. Thus, if one lacks confidence in the predictability of both scientific understanding and new technology, the safest course would seem to be investment in short-term emission reductions.

This potentially expensive strategy may be more palatable if, as Manne and Richels suggest, the United States keeps a global perspective on CO_2 abatement costs. The energy mix, economic growth rate, and availability of alternatives will vary considerably among nations. So the total costs of cutting emissions worldwide could be substantially reduced by a system of emission trading, in which nations with low abatement costs can transfer the right to consume carbon to high-cost nations like the United States (perhaps for a fee, as in the U.S. acid rain program).

Hazardous Omissions

Despite some commonsense proposals, the book unwittingly illustrates some of the limits of any macroeconomic approach to dealing with climate change. Because Global 2100 assumes that energy markets function reasonably well, the opportunity for large policy-driven improvements in energy efficiency and alternative energy sources is ruled out. Yet recent studies by the National Academy of Sciences and the Office of Technology Assessment conclude that there are enormous opportunities for improving energy efficiency and reducing CO_2 emissions today through better lighting, motors, heating and cooling equipment, and other technologies. These measures would in many instances save money—the proverbial free lunch rejected by conventional economic theory. The challenge for decision makers is to determine whether policies for seizing these opportunities (energy taxes and efficiency standards, for example) may themselves be so difficult or unacceptable that the cure is worse than the disease. Models like Global 2100 have nothing to say about this because they assume that any large savings have already been captured by the marketplace.

Another problem is that Manne and Richels deal with only half the economic question—the cost side. Most economic studies (Cline's excepted) suffer from the same omission because the benefits of addressing climate change are difficult to ascertain, while the short-term costs are only too obvious.

These studies assume that diverting investment into efforts to protect the environment reduces GNP, yet they fail to consider the equal or greater GNP losses that are *caused* by climate change. Nor do they acknowledge that properly structured environmental regulation can enable countries to anticipate international demand. As Cline notes, Germany has adopted a policy that would impose short-term costs on industry by unilaterally regulating CO_2, but it may gain an advantage in technologies other countries will adopt a few years hence. The United States has benefited similarly from leadership on policies to protect the ozone layer. Driven by regulatory pressure in the 1980s, U.S. companies developed chlorofluorocarbon substitutes that have paid off in international markets. Conventional models like Global 2100 make no allowance for the link between policy and innovation.

The authors of *Buying Greenhouse Insurance* deserve credit for their clear explanations of the black art of macroeconomic modeling. At this stage, however, it is apparent that such modeling is on no more solid ground than the environmental modeling it seeks to complement. ■

ALAN S. MILLER is director of the Center for Global Change at the University of Maryland.

BOOKS

FLIGHTS OF FANCY

The Staircase
Volume 1: *History and Theories*
Volume 2: *Studies of Hazards, Falls, and Safer Design*
by John Templer
MIT Press, $55

BY MICHAEL HOLLERAN

ALTHOUGH stairs are not something we ordinarily give much thought to, our footing and even our lives depend on their regularity. With each step, we take "a controlled fall forward" without looking, trusting the next step to be where we expect it. The more you hear about stairs, in fact, the more frightening they sound. "In terms of injuries inflicted," writes John Templer in *The Staircase*, "the stair of today is not different from that of 5,000 years ago. A fall down the stairs is comparable to falling into a hole with jagged rocks at the bottom." About a million people a year in the United States hit those rocks hard enough to land in the hospital. Perhaps 4,000 of them die, about as many as drown or are killed by fire.

Yet we have done comparatively little to make stairs safer. Unlike cars, stair technology is no one's proprietary responsibility, and the building industry is fragmented into mostly small-scale enterprises, regulated locally. Its rules

are a sort of architectural folklore, emerging from "well-intentioned ideas and experience" rather than formal investigation. "With this record of research," says Templer, "the automobile would still be the perilous machine it was at the turn of this century. The stair still is."

Templer, a professor of architecture at Georgia Tech, has spent years testing builders' rules of thumb by watching and measuring people on stairs. Of the book's two volumes, the second—*Studies of Hazards, Falls, and Safer Design*—is a distillation of this life's work, and is the dominant twin. It encompasses the epidemiology and etiology of stair accidents (who falls and what happens to them, as well as what causes their falls); the biomechanics, physiology, and cognitive psychology of using stairs; and the traffic engineering and social psychology of sharing them with other people.

Softer Landings

Templer neither disdains nor defers to the commonly used formulas for stair making. The standards followed in some building codes he finds too permissive (allowing treads so narrow they make us descend sideways), others too restrictive (slavishly applying an equation written by François Blondel in 1675—the tread plus twice the riser equals $25^1/_2$ royal inches—as if everyone had the same gait). Some address the wrong questions: many building codes prohibit more than $1^1/_2$ inches between the handrail and a wall, yet Templer says what's really needed is a *minimum* distance, since large knuckles require more clearance. And although codes aim to prevent falls, they do nothing to minimize injuries once prevention has failed. Templer suggests that designers embrace the auto safety concept of "crashworthiness" and build what he calls the "soft stair," with resilient surfaces and no sharp projections. Writing building codes involves a special responsibility, he suggests, because while they are enacted to establish minimums, they are then treated as standards and seldom exceeded.

Before discarding a stair-building rule, Templer tries to reconstruct the reasoning behind it. For example, ergonomic studies show that railings would be easier to hold if mounted nine inches higher than most codes specify. But as we begin to fall down the stairs, 190 milliseconds pass before we reflexively attempt to regain control; in this time we drop about seven inches. Perhaps when we need the railing most, rule-of-thumb knowledge has put it in just the right place after all.

Templer also tells us when a formula will not do and we must exercise judgment instead. Codes sometimes prohibit single steps, but this rule seems impractical and is routinely ignored. Single steps are dangerous because they are easy to overlook, so Templer suggests confining them to places where we expect them, such as entrances. A stair accident results from "a failure of expectations"—thus, where customs govern our expectations, we ought to follow custom.

But knowing how buildings will continue to be made, he frames his conclusions wherever possible as new formulas, suitable for adoption in building codes and for use by archi-

tects at their drawing boards. He even pulls these together in an appendix, tacitly recognizing that there is a larger market for rules than for the thought behind them.

Stepping into the Past

By the nature of Templer's subject, most of the world's architecture falls within the purview of his other volume on stairs, *History and Theories*. We watch medieval or Renaissance explorations of form, and then fast-forward to their full expression in new materials such as cast iron and reinforced concrete.

Templer slices through chronology and style, focusing instead on form, and at his best applies his technical knowledge to this history. Did castle owners, as is often reported, build right-handed spiral stairs so defenders could hold onto the central newel while keeping their sword hands free? Having examined the biomechanics of sword wielding on stairs, he is skeptical. Did Renaissance palace designers emphasize garden stairs because they were building on hillsides? Templer raises the possibility that, on the contrary, they sought sloping sites because they wished to build stairs. He also finds that as the public rooms of these palaces moved from the ground floor up to the *piano nobile*—a raised main story—stair design served to integrate levels and "distract the stair user from the act of climbing." These "baroque stair fantasies" might be a building's biggest room.

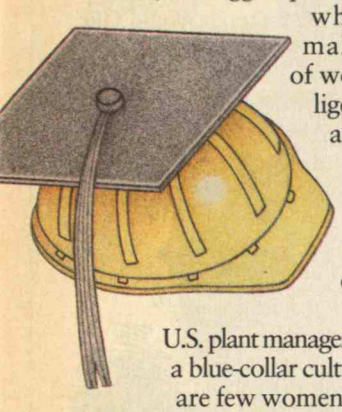
Here Templer the historian finds himself at odds with Templer the engineer. One can't help but notice that few of the Renaissance and baroque staircases he extols in volume 1 could be built if designers followed the rules in volume 2. For example, in *History and Theories*, baroque stair designers create continually unfolding views that lift the climber to the next floor. In *Studies of Hazards, Falls, and Safer Design*, the "orientation gradient" measures how much new spatial information a staircase requires us to assimilate as we move. Templer points out that not all views from stairs are unsafe, but he still ends up reducing the staircase to a single function—a place to move while remaining uninjured—and thus categorizing visual experience as a hazardous distraction.

Although *The Staircase* is meant to bridge the schism between architecture and research, splitting this work into two volumes only perpetuates the problem. Good architecture, wrote Vitruvius in the first century BC, displays "commodity, firmness, and delight"—function, structure, and aesthetics, in today's less poetic terms. Templer puts commodity and firmness in the second volume, and delight in the first. ■

MICHAEL HOLLERAN is a professor of urban and regional planning at the University of Colorado at Denver. He last wrote for TR *on the city designs of Kevin Lynch (Nov./Dec. 1991).*

REVAMPING VOC ED

In "Building a Smarter Work Force" (*TR October 1992*), Ray Marshall and Marc Tucker address a subject much neglected in debates on competitiveness, education, and labor-management relations. "Voc ed" represents the last real hope of lots of young Americans eager to find their way in a tough economy. However, the biggest problem for those who seek to make the most of workers' intelligence and creativity may be the chicken of managerial habits, not the egg of education. The typical U.S. plant manager still cultivates a blue-collar culture. He (there are few women managers in manufacturing establishments) sports short-sleeved shirts and cigars and identifies with his hourly workers. He openly resents the advice of PhD experts on process technology and wonders why corporate executives do not include him in discussing technological strategy. Given this scenario, what can be done to make the workplace user-friendly for the kind of workers Marshall and Tucker envision?

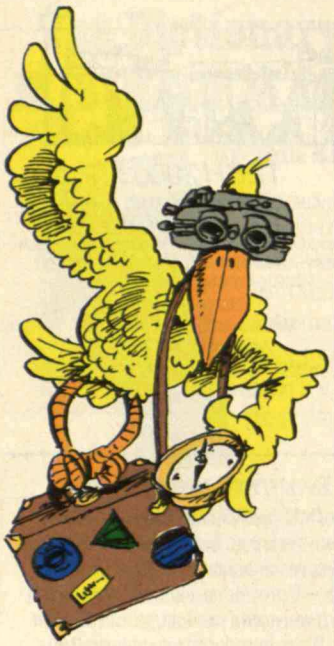


I suggest that the governors in each state negotiate a compact among vocational schools, community colleges, unions, associations of industrial and service employers, and the state agencies charged with overseeing education and worker training. Employers as well as educators would commit themselves to training young people for rewarding work and plant managers for creative and challenging workplaces. Part of that commitment would be to provide work-study programs in qualifying businesses. State and federal departments of Labor and Education should look at the National Science Foundation's State Systemic Incentives Program for a successful model.

LEWIS M. BRANSCOMB
John F. Kennedy School of Government
Harvard University

Classifieds

Notes



The Great Red North

How migratory birds know which way is north may no longer be a mystery. Klaus Schulten, a biophysicist at the University of Illinois, speculates that special receptors in the birds' eyes enable them to actually see the earth's magnetic field lines as easily as if they were arrows—in fact, red arrows—pointing the way.

Schulten points to several recent experiments that led him to this conclusion. One study showed that when birds migrating south were placed in a room that was both symmetrical and uniformly lit, they clustered in the southern half of the room. This finding, Schulten asserts, challenges popular theories that birds do their navigating based on landmarks or the position of the sun.

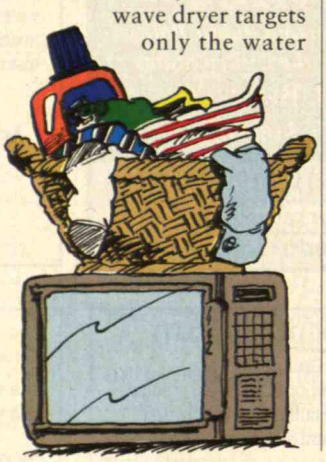
Other studies show that when birds are placed in total darkness or when the magnetic field around them is altered, they completely lose their sense of direction. Schulten believes the birds combine the input from magnetic lines of force with certain wavelengths of light. In fact, several recent experiments show that migratory birds are unable to sense north when exposed to red light. Schulten concludes that the magnetic force lines must appear as red since that is the only color that would be invisible in the presence of artificial red light.

Nuking the Family Wash

Microwave technology may soon be branching out from the kitchen to the laundry room, thanks to a new prototype clothes dryer developed by the Electric Power Research Institute. The unit not only dries faster, claims EPRI, but because the temperatures are lower than those generated by conventional dryers, it also cuts electricity consumption by 20 percent and causes less shrinkage and wear.

Conventional dryers heat the air that is blown into the drying drum to temperatures as high as 350°F. Evaporated water from the wet clothing, carried out of the dryer as vapor, cools the air in the drum considerably, but the temperature of the clothing still typically reaches 160°.

Rather than heating the air and the clothes, the microwave dryer targets only the water molecules. "When you heat something in a microwave oven, you are heating the water molecules in the food," says John Kesselring, senior project manager for EPRI. "The microwave drying process is similar." Because the air that is blown in to remove the vapor is unheated, temperatures inside the experimental unit generally do not exceed 110°.



The first commercial dryer will not be available for at least three years, says Kesselring, as he and EPRI colleagues test the effects of microwaves on brightly colored clothes and on woolens, silks, and other fine fabrics. They are also investigating a proprietary process that he expects will prevent thin metal objects—such as bobby pins— from heating up and scorching the clothing.

Make Room for Titans

Astronomers have known since the early 1970s that Saturn's largest moon, Titan, contains most if not all of the organic building blocks of life that were present on primordial earth. But most scientists have assumed that at -180°F, the remote satellite was permanently locked in a deep freeze, unable to mix its organic chemicals with liquid water, an ingredient vital to the evolution of life on earth.

Recently, however, W. Reid Thompson, a space scientist at Cornell University has asserted that Titan's solid-ice interior does occasionally melt and therefore could support evolution. Thompson's theory is based on the assumption that Titan, like Saturn's other frigid moons, has been heavily cratered by meteoritic impacts during the last 3 billion years. When the meteorites crash onto the frozen moon, he suggests, their kinetic energy is converted to thermal energy that thaws the ice and splatters a mixture of water and organic material over the surface.

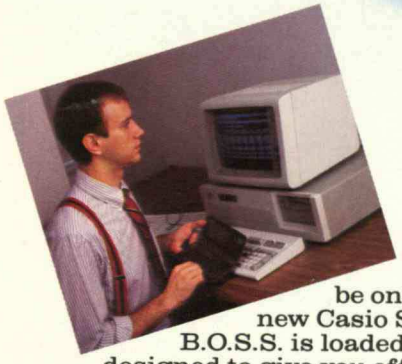
Furthermore, Thompson points out, although the surface of a pool created by an impact would immediately begin to freeze, it would take some 300 to 400 years to freeze solid because the typical pool would be at least 100 meters deep. The top layer of ice would serve as insulation against the cold at the surface, allowing chemical evolution to take place below.

Carl Sagan, director of Cornell's Laboratory for Planetary Studies, says that if the Titan impact model is correct, planetary scientists will have to reassess their notion of where life may be possible. "This doesn't necessarily mean that it's likely there is life on Titan," Sagan says, "but it may mean that prebiological organic chemistry has gone much further toward life than anyone had earlier thought. And the theory has applications for an enormous number of worlds where we might never have thought liquid water was available."

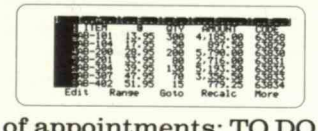
ILLUSTRATIONS: JON McINTOSH

The new Casio SF R20 Executive B.O.S.S.

We've built more into it so you'll get more out of it.



Among palm top organizers, there can only be one B.O.S.S. The all new Casio SF R20 Executive B.O.S.S. is loaded with features designed to give you effortless access to vital information, such as a built-in Lotus 1 2 3 file compatible spreadsheet. A 40 character by 10 line oversized display allows simultaneous viewing of its multiple functions and a "window" type menu provides easy access to its numerous features: SCHEDULING with alarm to remind you of appointments; TO DO, a check list for vital tasks; plus FREE FILE, an easy-to-use text editor with functions like cut, copy and paste. There's even a one button "Help" feature for all built-in functions.



With its large 256K memory, the Executive B.O.S.S. can hold thousands of appointments, phone numbers, addresses, memos and calculations. Plus, the B.O.S.S. series features IC card expandability for even more memory, communications and various special applications. And the Executive B.O.S.S. can be linked to your PC with its optional interface. All of which goes to show that the Casio SF R20 is the one B.O.S.S. that actually makes your job easier. For more information and a store location nearest you, please call **1-800-423-1700.**

We believe they should be seen and not heard.

In a perfect world, planes would soar as silently as the one on this page. And while nobody's perfect, we at Lufthansa have always led the way on environmental issues. We're intensely involved in the development of new aircraft, investing billions of dollars to update our fleet. Replacing older planes with newer ones designed to be far more quiet. Today, Lufthansa planes have an average age of just five years. Which puts us among the youngest in the air. Our new aircraft produce just a fraction of the noise compared to their predecessors and are infinitely more fuel efficient. And fewer emissions result in less pollution. It may not be perfection, but it's our passion to pursue it that can make all the difference in the world.

A passion for perfection.®

Lufthansa

For reservations or information call 1-800-645-3880 or see your Travel Agent. Lufthansa is a participant in the mileage programs of United, Delta and USAir.